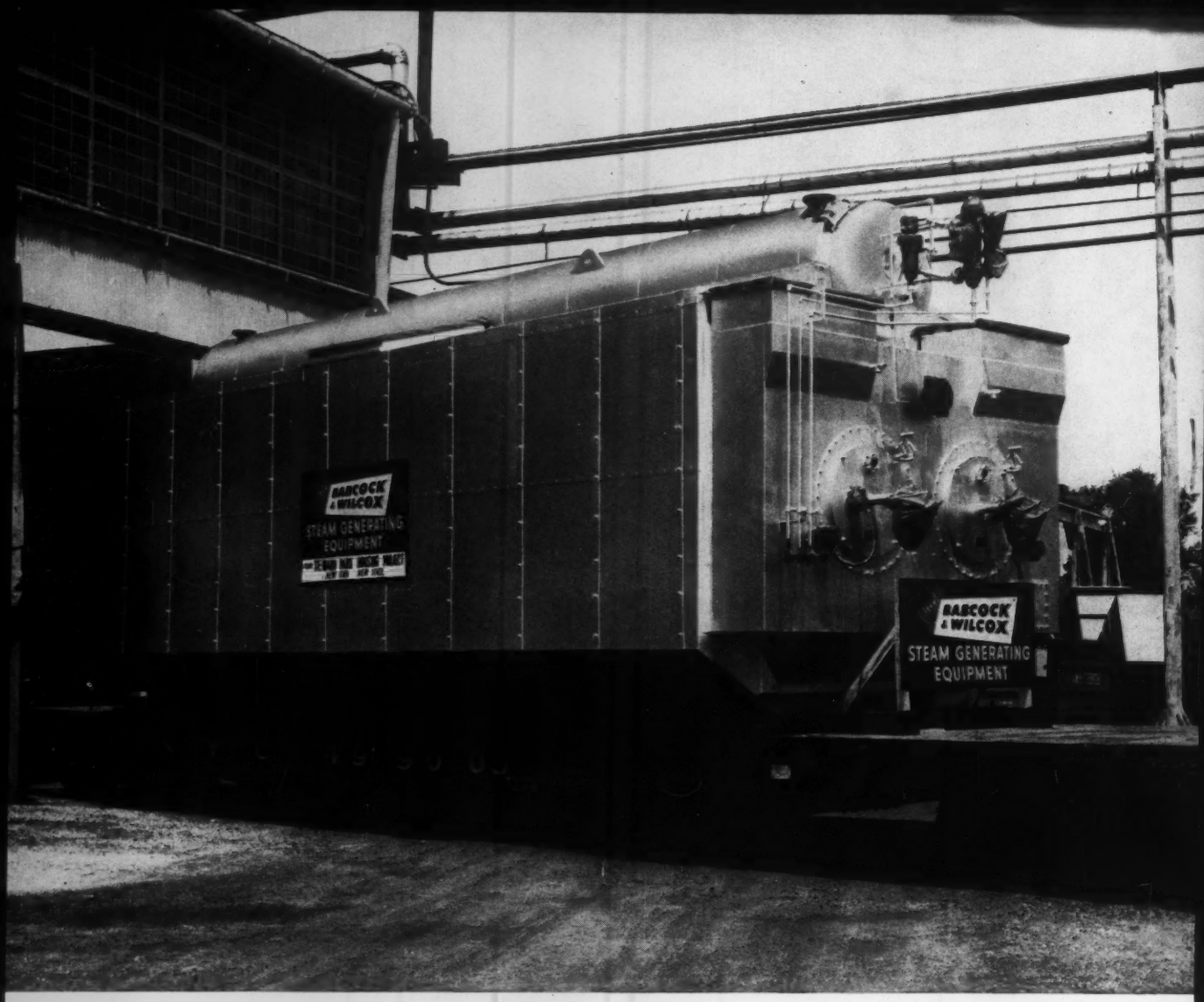
MECHANICAL ENGINEERING

May 1960

Design Engineering Issue



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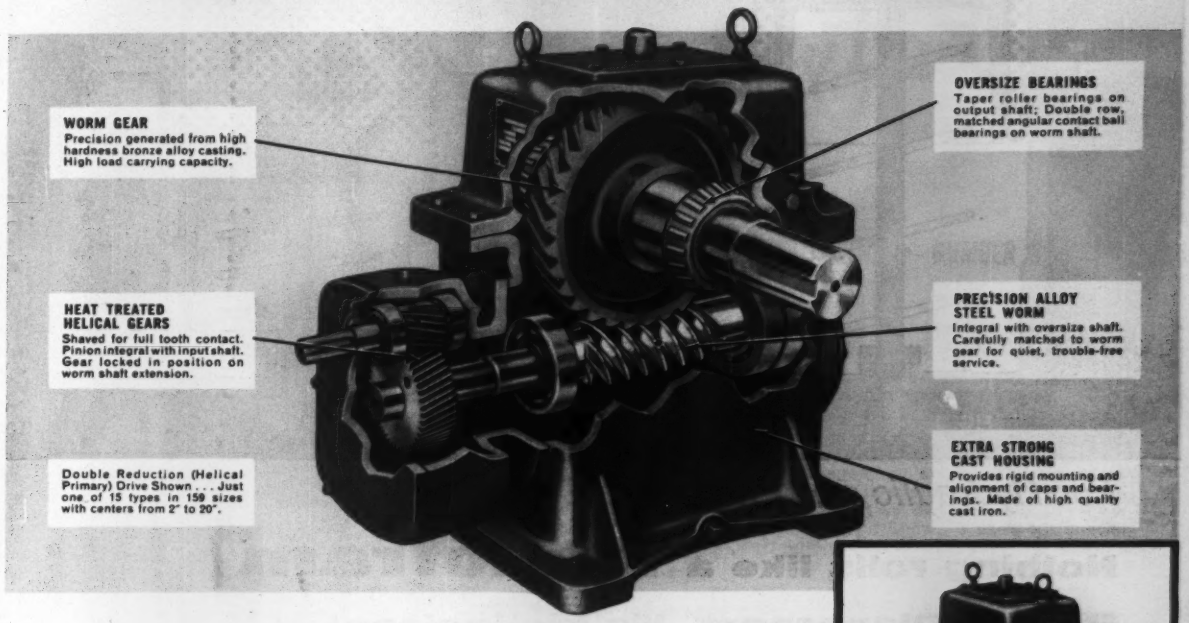
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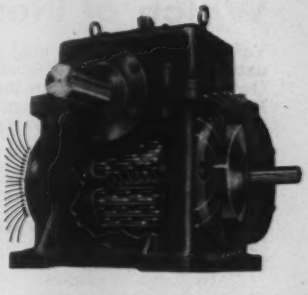

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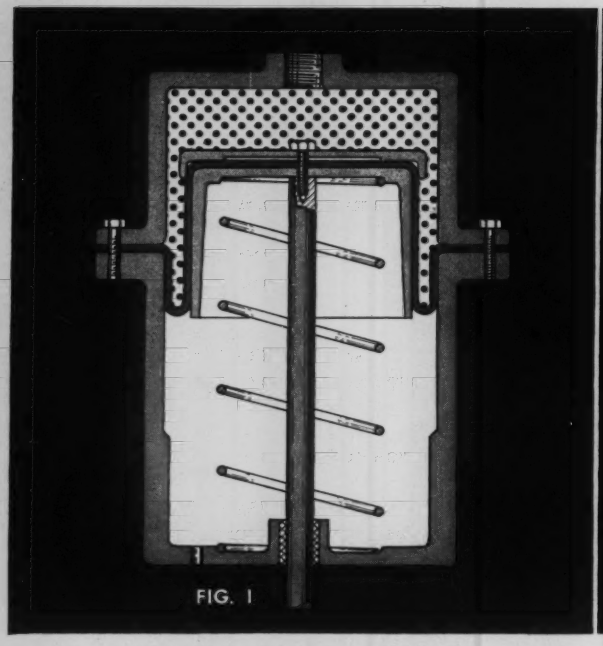
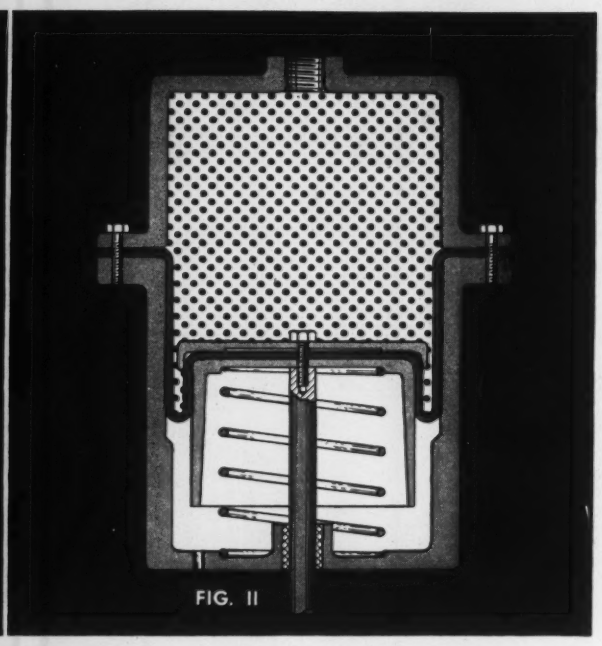


FIG. I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Contents

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THE COVER

These are the symbols of the ASME Design Engineering Conference and the concurrent Design Engineering Show. This issue of MECHANICAL ENGINEERING contains special inserts, one with condensations of four technical papers that will be presented, the other giving high lights of the Conference and Show. This is our special bow to the creative engineers who design and produce the nation's machinery.

DECONTROL THE ENGINEER?.....**H. H. Goode** 36

More engineering per engineer. The tools are at hand, tools like the computer. But basically it's a question of policy. Will management free the engineer for the creative engineering task?

DIRECTIONS IN DESIGN ENGINEERING 39

Automatic Assembly.....**Robert Esken**
Welding Processes.....**J. J. Chyle**
Fabrication by Explosives.....**Vasil Philipchuk**
Hydraulics: Standard Components.....**E. I. Brown**

Do you know how to design machine parts for automatic handling and assembly? Here are articles for the designer, the engineer who carries the machine from an idea into a functioning reality.

ELECTROSTATIC PRECIPITATORS.....**H. J. White and W. A. Baxter, Jr.** 54

That "dispersoid" you've got to collect—alumina dust, gypsum, fly ash?—can be deposited by electrostatic precipitation. Here is a study of the calculation and design of the precipitator.

MORE LABORATORY FOR LESS MONEY...**C. E. Anderson and R. A. Gulick** 57

How often do you see engineering ingenuity? Here's some you can admire. They needed a versatile, expensive laboratory. What they had was a limited budget. But . . . they built the laboratory.

WHAT MAY BE AHEAD IN POWER PRODUCTION.....**G. B. Warren** 61

The view ahead, as seen by ASME's Past-President, who is also GE's vice-president and consultant, Turbine Division. What do the next 20 years promise in nuclear power, in the fuel cell—and fusion?

TOMORROW'S ENGINEERING EDUCATION.....**A. H. Shapiro** 66

We are in the third great revolution in man's way of life, and we have not begun to solve the problems it poses in the training of engineers. Look for bold new concepts in engineering education.

WAREHOUSING WITHOUT PALLETS.....**I. M. Footlik** 67

The pallet, so efficient, still represents weight and bulk to be handled. Can it be eliminated? Yes, says this report, describing a truck-lift attachment built on the principle of the human hand.

Contents continued on following page

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Contents (continued)

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READERSHIP

RESEARCH

Departments

EDITORIAL 35

BRIEFING THE RECORD 70

Unified National Power System 70
510,000-Kw Turbine-Generator 71
Soot Blowers 71
Continuous Weld Inspection 72
Vibratory-Finishing Equipment 72
Ultrasonic Welding of Titanium 72
Magnetohydrodynamic Generator 73
Commercial Thermoelectric Generator 73
Modular Offices 74
Stuck Drill-Stem Retriever 75
Industrial-Process Computer 75
Versatile Vertical Machine 76
Electrohydraulic Turbine Control 76
Clinch River Power Plant 77
Portable Heat Exchangers 77
Enrico Fermi Heat Exchangers 78
Expansion-Engine Refrigerator 78
Welding Cast Iron 78
Plastic Fume Scrubber 79
Nuclear Briefs 80
Materials Briefs 81

PHOTO BRIEFS 82

EUROPEAN SURVEY 84

ASME TECHNICAL DIGEST 86

Power 86
Fuels 86
Aviation 86
Gas Turbine Power 88
Textiles 88
Aviation—Reliability 89
Hydraulics 89
Heat Transfer 91
Mechanical Pressure Elements 96
Power Test Codes 96
Production Engineering 96
ASME Transactions for April, 1960 97

COMMENTS ON PAPERS 98

REVIEWS OF BOOKS 99

BOOKS RECEIVED IN LIBRARY 100

THE ROUNDUP 104

Nuclear Congress 104
SwRI Reports on Pressure Vessel Research 107
Meetings of Other Societies 110
CIGRE Meeting 110
Coming Meetings 111
Combustion Engines 112
U. S. Forest Products Lab Celebration 112
Research 113
People 114
Tyro Tycoon 115
N. Y. C. Scientific Literature Resources 115
Education 116

UNITED ENGINEERING CENTER 118

THE ASME NEWS 120

Applied Mechanics Conference 120
SAM-ASME Management Meeting 121
GTP and Hydraulic Conference 122
Symposium on Load-Carrying Capacity of Bearings 126
M-E Curriculum 127
ASME Power Show 127
Managerial Control 128
Junior Forum 129
ASME Coming Events 130
Engineering Index—1959 131
ASME Textile Conference 131
Executive Committee Actions 131
Personnel Service 133
Candidates 136
Obituaries 137

DESIGN ENGINEERING CONFERENCE AND SHOW 139

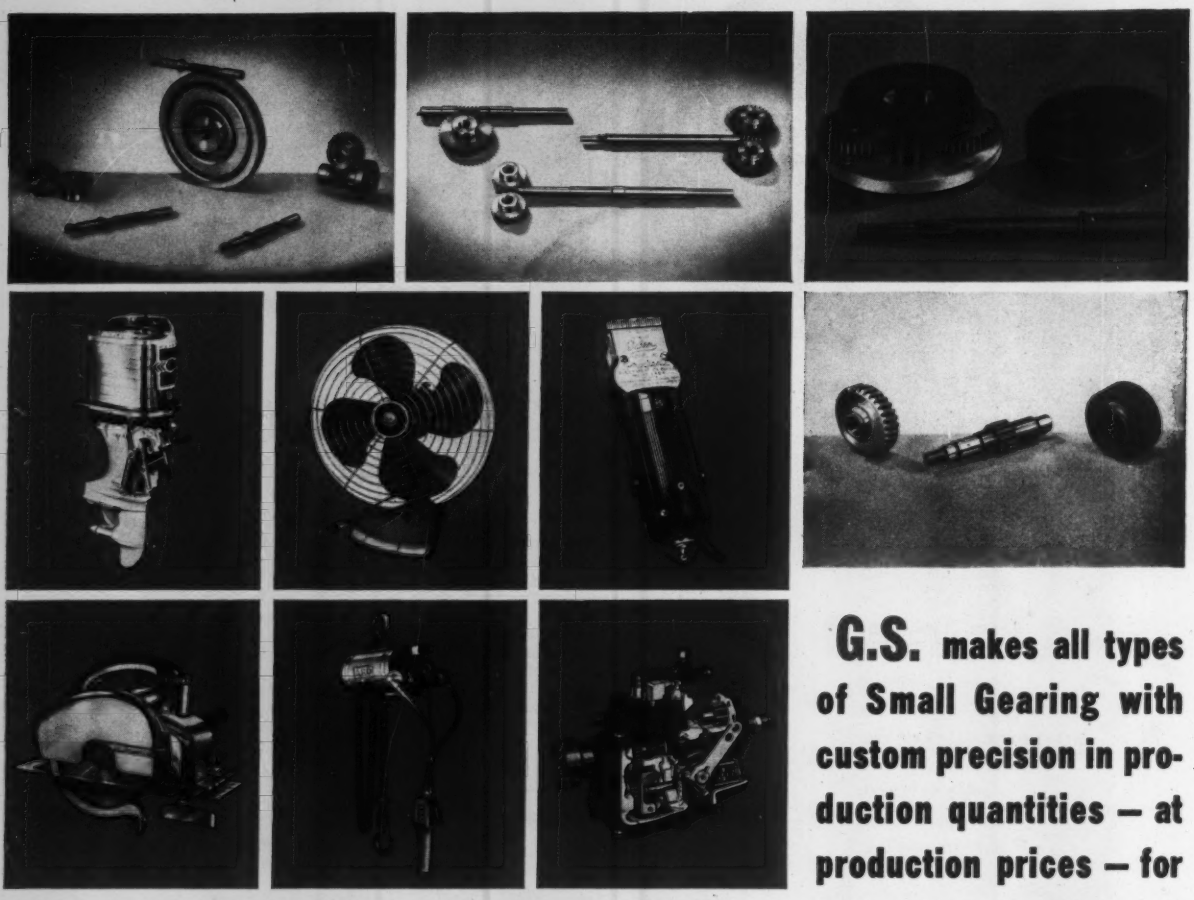
Exhibit Floor Plans 140
List of Exhibitors 140
Conference Program 144
Conference Paper Digests 144

KEEP INFORMED 149

204 ..... CONSULTANTS

CLASSIFIED ADS 197

206 ..... ADVERTISING INDEX



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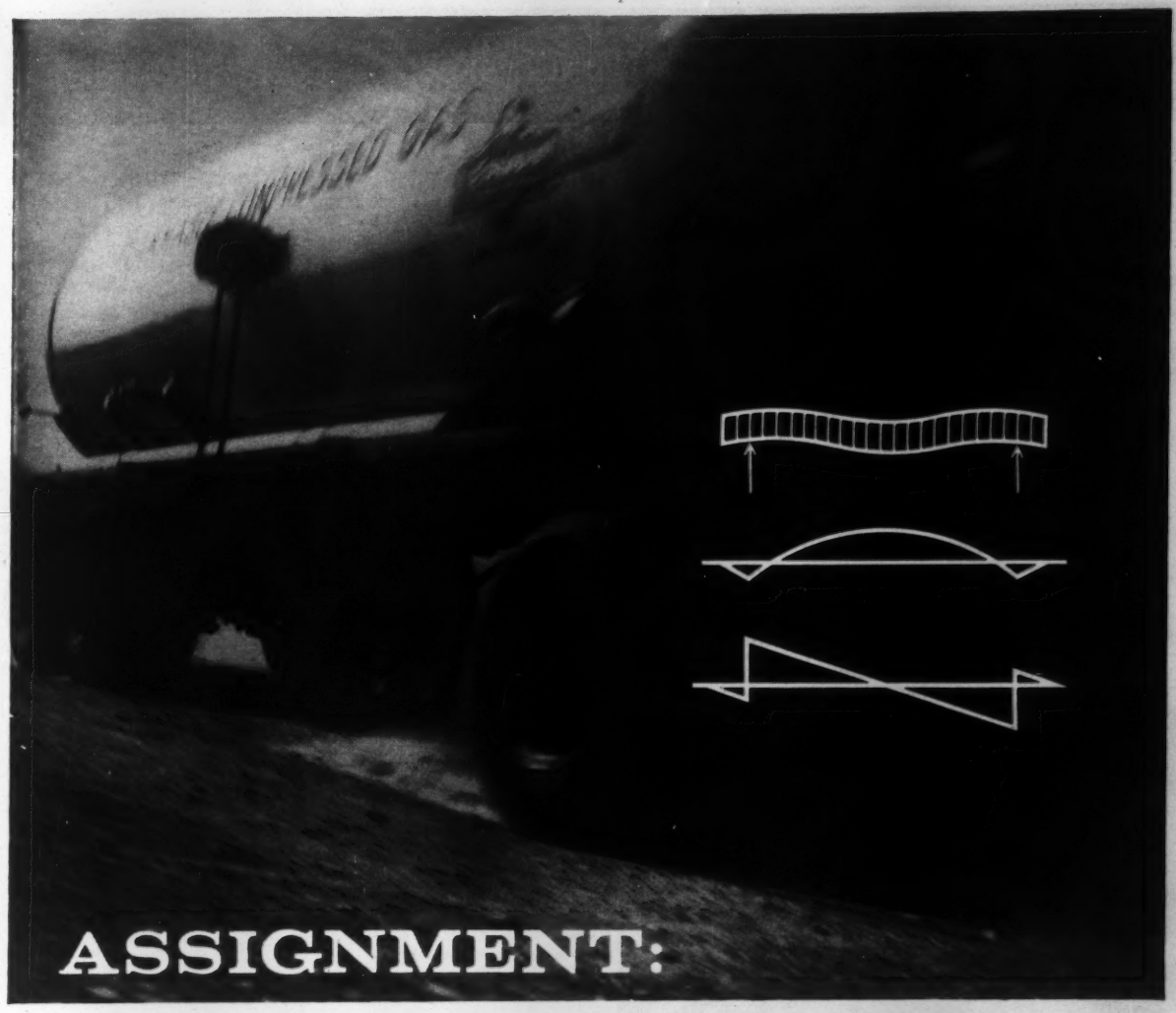

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Requirement: metal pipe and tube to insure corrosion-free fluid handling at low initial cost and minimum upkeep

Key to good design: specify low-cost, trouble-free tubular products of Alcoa Aluminum

The overpowering volume of pipe and tubing needed in the process industries makes it one of the biggest single material investments in most plants. Historically, the repair, maintenance and replacement of piping systems has been too, one of the biggest causes of an alarming increase in maintenance costs. Both factors make vital a clear understanding of the rather remarkable advantages of aluminum pipe and tube.

First of all, from a cost standpoint, aluminum is very frequently the lowest cost material suitable for a wide variety of applications in moving fluids through a plant. Consider, for example, the fact that the initial cost of aluminum may often average as much as 50 per cent less than that of admiralty for identical applications. Even greater savings apply when other metals such as stainless or mild steel are compared with aluminum.

Beyond these initial cost savings, aluminum provides significant maintenance benefits. For instance, no other commonly used metal offers aluminum's great resistance to corrosion. And the corrosion resistance for specific alloys exposed to particular environments can be determined from a substantial body of factual service data accumulated by ALCOA over the past 40-odd years.

It is hardly surprising that aluminum, in a variety of tubular forms, is gaining the confidence of more and more designers and builders in the process industries . . . as suggested by the aluminum applications described on these pages. ALCOA'S engineers are anxious and willing to share their factual knowledge of aluminum which inspires this confidence. They are doing so through a series of engineering conferences being held this year in major cities around the country. Your local ALCOA sales office will be happy to furnish details.

You may also wish to avail yourself of the body of ALCOA literature which describes in technical detail the known performance characteristics of aluminum in a variety of process industries applications. Simply fill in and mail the coupon opposite.

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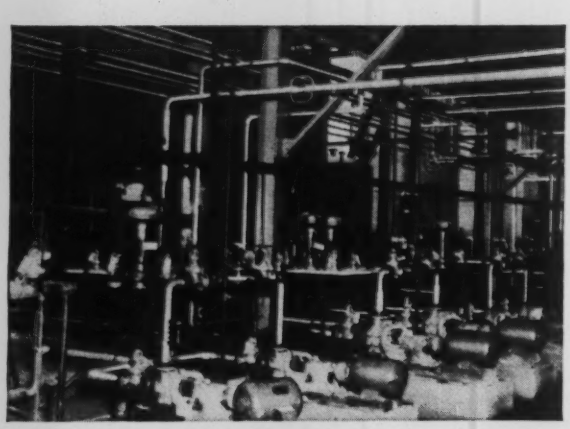
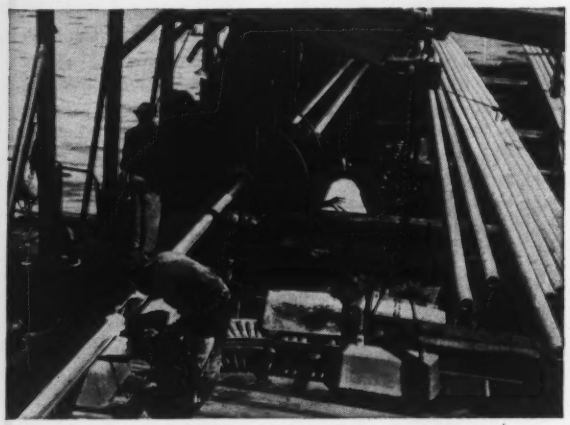


Process piping of Alcoa Aluminum is shown here in a system designed to handle liquid sugar. The natural corrosion resistance of aluminum prevents contamination of the syrup, insures long service life and prevents excessive maintenance. Its scavenging action reduces undesired heavy metal contamination, thereby improving the end product. And aluminum's low friction factor permits fast flow without excessive pumping costs.

This aluminum pipeline is shown being welded and laid in Lake Maracaibo, Venezuela. Aluminum—without special coatings—has proved highly suitable for this operation because it resists so well the corrosive attack of the brackish waters in the lake. Since no coating is required, the low initial cost of the aluminum has proved a significant benefit. The light weight of the aluminum pipe speeded laying operations, and it has no vulnerable coating which would require babying the pipe.



Alcoa Aluminum jacketing keeps the thermal insulation on these large diameter steam lines fully effective. The light, bright aluminum jacketing shields over 5½ miles of piping and insulation from rain, snow, dirt and ice while providing effective protection against a highly corrosive industrial-marine atmosphere.

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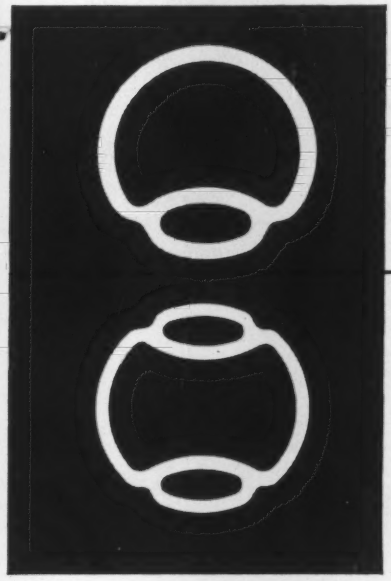
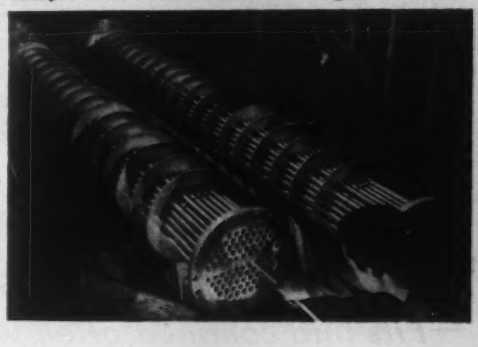


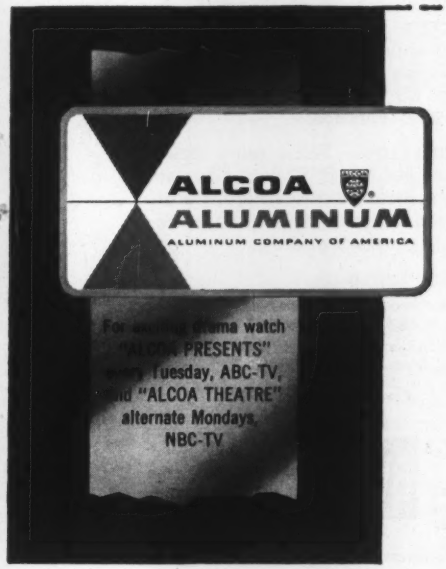
Alcoa UNITRACE is the light, strong, corrosion resistant pipe which provides steam and product passages in a single extruded unit. It has proved an excellent way to cut cost and improve the efficiency of steam traced lines—by eliminating costly external steam jackets or inefficient tracer tubes. Now a new product,

Alcoa DUOTRACE makes possible the same important benefits in steam traced systems where recirculation is desirable. As shown, DUOTRACE provides two trace passages plus the product passage in one extruded unit. Flange and Trace Cap fittings compatible with conventional piping are available for both UNITRACE and DUOTRACE.

Design Note: Consider UNITRACE and DUOTRACE as low-cost successors to both heat exchangers and preheaters.

Alcoa Aluminum heat exchanger tubing is frequently the lowest cost material with suitable corrosion resistance for a variety of heat transfer applications. Moreover, aluminum frequently displays significant extra benefits—as in this pair of aluminum oil-to-oil exchanger bundles for preheating vegetable oils. Here, the aluminum alloys have no catalytic effect on the oxidation of the vegetable oil.





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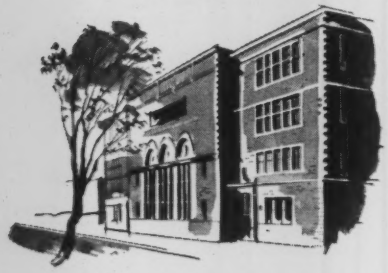

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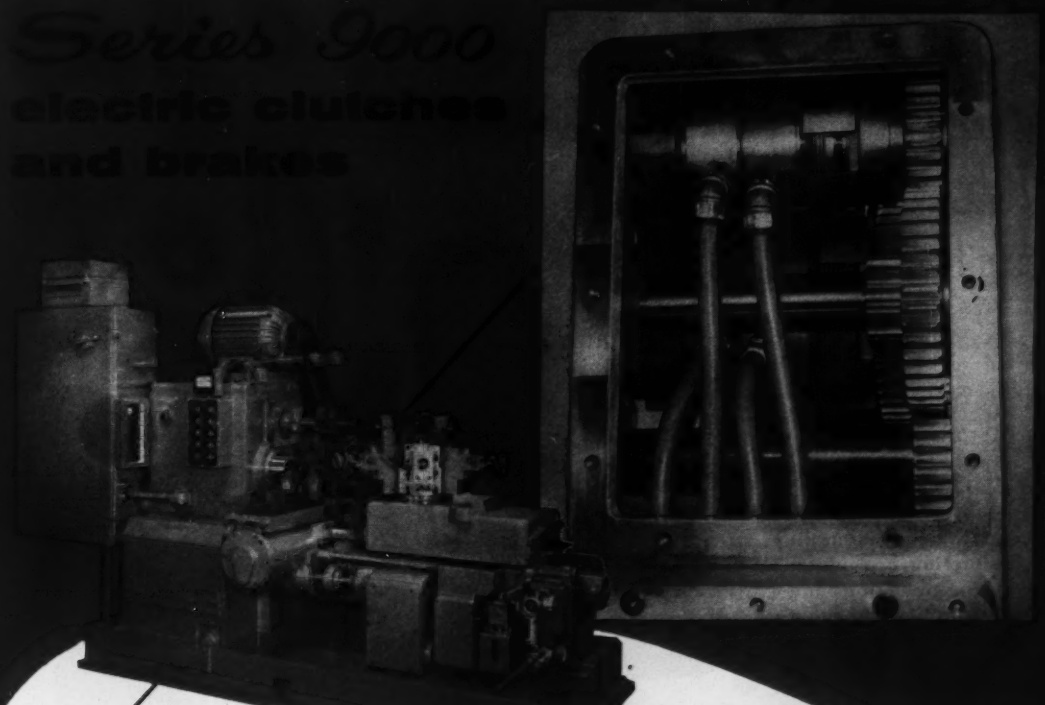
Air Conditioning, Heating, Refrigeration and Ice-Making Equipment • Products for Home, Commercial and Industrial Applications

Maxitorq

Series 9000 electric clutches and brakes



an outstanding design feature of tape-controlled automatic turret lathes

Five Maxitorq Series 9000 Electric Clutches are used in the all-new Potter & Johnston No. 3E-15 Tape-Controlled Automatic Turret Lathe. Four are used in the headstock to provide automatic spindle speed changes and a fifth is used as a master clutch in the feed drive. These clutches of advanced design have PROVED their ability to assure consistent, positive and extremely fast action; essential to these machines. They transmit full load, are self-compensating for wear and permit great flexibility in control.

With operation induced entirely by magnetic flux, Maxitorq Series 9000 Electric Clutches are well adapted to a wide range of machine tool drives. They are simple and rugged in design, require no adjustments, can be used *either as a clutch or brake* and are built to American Machine Tool Standards. Disc separators not only separate discs, providing a drag-free neutral without heating, but also break up residual magnetism and permit extremely fast, positive action.

The 9000 Series Clutches have a minimum of moving parts and the electrical operating unit remains stationary, hence, there are no brushes, slip rings or complex wiring. Maxitorq Clutches operate on 110 V. A. C. rectified to 90 V. D. C. Other voltages on special order.

If you have a clutch or brake application where you are looking for new and improved performance, bring your problem to us.

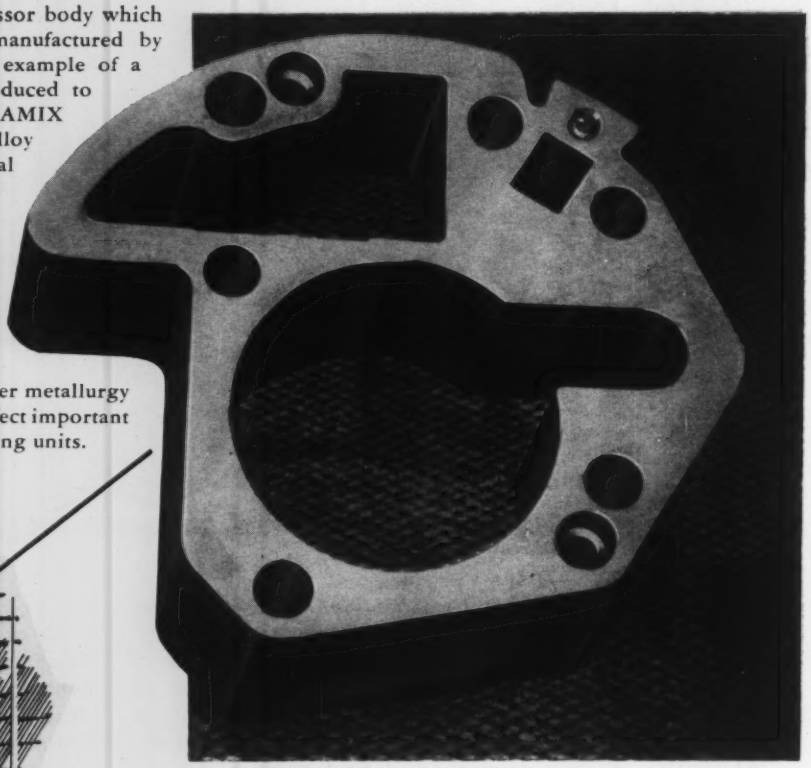
Phone, wire or write Dept. ME for Series 9000 Bulletin.

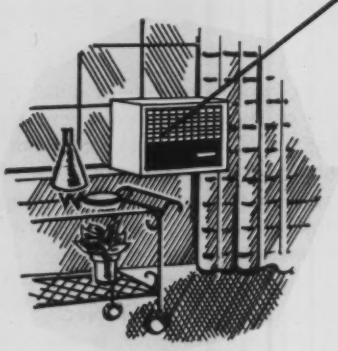
The Carlyle Johnson Machine Company, Manchester, Conn.

3CJ59

GRAMIX® COMPRESSOR BODY IS VITAL PART IN GENERAL ELECTRIC AIR CONDITIONER . . . this GRAMIX part is a new concept in powder metallurgy techniques . . . engineered to meet requirements of GENERAL ELECTRIC's new compressor design

This large, complex shaped compressor body which is employed in air conditioners manufactured by General Electric is an outstanding example of a GRAMIX part engineered and produced to exacting specifications. As in all GRAMIX products of powder metallurgy, the alloy was created to meet exacting physical properties required in this particular application. Correct briquetting, controlled sintering procedures, precise finishing operations and rigid quality control throughout the manufacturing process assures General Electric uniform, dependable GRAMIX parts. The production of this body as a product of powder metallurgy has also enabled General Electric to effect important design changes in their air conditioning units.





This part is shown full size. Actual weight: 2¼ lbs.

PM MEMBER

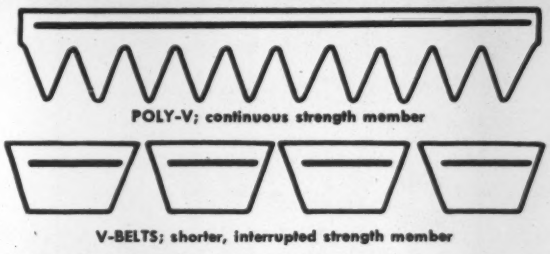
Write today for these helpful engineering manuals. Engineering Bulletin No. 18 covers design and metallurgical requirements and alloy selection of GRAMIX bearings. No. 19 contains facts about GRAMIX Machine Parts and No. 21 contains general information on GRAMIX products from Powder Metallurgy. Get your copies now.

X-274-1

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 4, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES



"MORE USE PER DOLLAR"

Poly-V Belt is a single unit with even, uniform pull. Uninterrupted strength member gives much higher hp capacity per inch of drive width. No belt drive delivers as much power in the same space as Poly-V!

THIS R/M POLY-V® DRIVE OUTLASTED V-BELTS 8-1!

V-belts were replaced every six months on this gas pump drive in a southern chemical plant—until the company converted to R/M's patented Poly-V Drive. The single Poly-V Belt pictured above has been in operation for over 4 years on a barium process operation. Four years for the R/M Poly-V Drive versus 6 months for an ordinary V-belt drive! The savings and advantages to production are obvious.

R/M Poly-V Drive solves difficult drive problems wherever heavy duty power transmission is required. Single unit design permits *narrower* Poly-V sheaves to deliver *equal* power in a much smaller space or much *more* power in the same space as a V-belt drive! The drive runs smoother because there's no sinking of belt in sheave grooves. Belt speed ratios remain constant from *no* load to *full* load for uniform power delivery—with less wear on belts and sheaves. V-belt "length matching" problems are completely eliminated . . . and just two belt cross sections meet every heavy duty requirement. Let an R/M Distributor show you other advantages of converting to R/M Poly-V Drive. Write for Bulletin M141.

- **More Power—Less Space**
- **Eliminates "Matching" Problems**
- **Maintains Groove Shape**
- **Assures Constant Speed Ratios**
- **Longer Belt and Sheave Life**
- **Cooler, Smoother Running**

RM1010

When You Change Drives, Convert to Poly-V and Be Sure!

RAYBESTOS-MANHATTAN, INC.

MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY

RM

ENGINEERED RUBBER PRODUCTS ... MORE USE PER DOLLAR

OWNERS:
Southland Life Insurance Co.

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THIS TEXAS GIANT

. . . draws its breath from CLARAGE equipment

Standing tall on the Dallas skyline is the new Southland Center . . . a 42-story office tower and the connecting 29-story, 600-room Sheraton-Dallas Hotel. Here, as in so many other impressive structures, Clarage equipment is in use — 86 Type NH system fans, 4 Ready Unit ventilating sets, 6 Unitherm fan units. Prompting the selection: Clarage's record for performing quietly, economically, *dependably* Investigate the *quality* line we manufacture for buildings of all types.

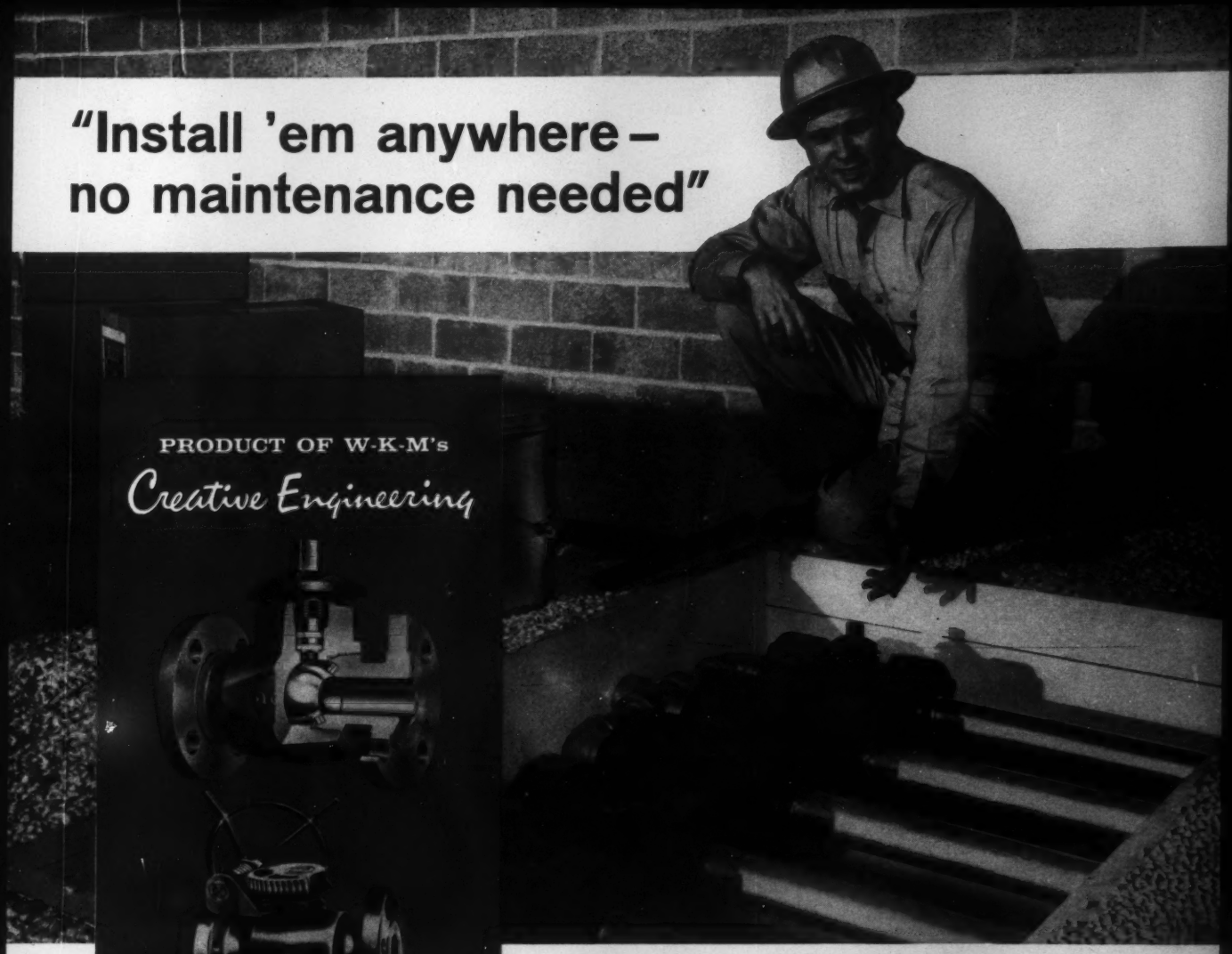
Dependable equipment for making air your servant

CLARAGE FAN COMPANY

Kalamazoo, Michigan

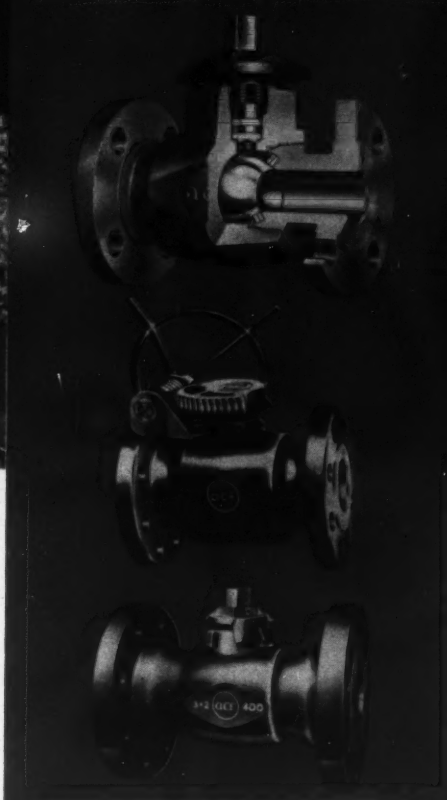
SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

"Install 'em anywhere – no maintenance needed"



PRODUCT OF W-K-M's

Creative Engineering



ACF non-lubricated Ball Valves feature Teflon stem gaskets and seats. There's no lubricant to cause sticking or contamination.

Working Pressures: In carbon steel with ASA ratings of 150 pound and 300 pound, and some sizes in ASA 600 pound; in semi-steel with 200 and 400 pound WOG ratings.

Sizes: ½" through 6". Regular port valves up to 8" x 6".

ACF non-lubricated Ball Valves

ACF Ball Valves are not only non-lubricated . . . but designed *throughout* for maintenance-free performance. For example: The ball is suspended between Teflon* seats under compression for leakproof sealing. Seats are protected from the lading flow. And the full bore conduit provides *smooth* flow, with no destructive turbulence . . . no more pressure drop than through an equal length of pipe.

A quick quarter-turn operates this rugged valve. Specify it. You'll get efficient, economical performance. *Available from leading suppliers everywhere.*

* Du Pont Trademark

WRITE FOR CATALOG 1000

W-K-M

DIVISION OF ACF INDUSTRIES
INCORPORATED
P. O. BOX 2117, HOUSTON, TEXAS

5922

One of a series

Catching Up with a Slippery Equation

What goes on when two moving surfaces are separated by a film of oil?

Simple question? Maybe, but engineers and mathematicians have been trying to answer this classic question of lubrication ever since Osborne Reynolds neatly stated the problem in equation form back in 1886.

Unfortunately, analytical methods for solving Professor Reynolds' partial differential equation worked only for unrealistic oil bearings, bearings with widths approaching zero or infinity. And approximate methods were crude, requiring a complete recalculation for each slight change in the bearing.

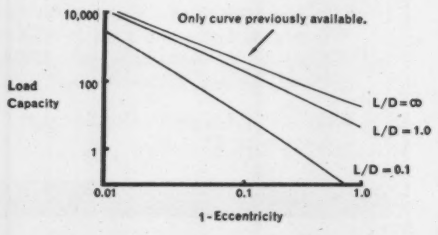
Recently, mathematicians at the General Motors Research Laboratories came up with the most versatile and efficient method of solution yet made. Their analytical method for solving the two-dimensional Reynolds' equation applies to all finite journal bearings — as well as other hydrodynamic bearings — with *no* assumptions or approximations about boundary locations. The new method uses a long-neglected energy theorem recorded by Sir Horace Lamb instead of the force relationship tried by Reynolds and others.

Besides being a valuable contribution to the theory of lubrication, this work has its practical side: namely, accurate, serviceable design curves for engineers. At GM Research, we believe delving into both the theoretical and applied sides of a problem is important to progress. It is a way of research that helps General Motors fulfill its pledge of "more and better things for more people."

General Motors Research Laboratories

Warren, Michigan

Hydrodynamic analyses have led to specific answers about bearing operation. Shown here are the oil pressure distribution (main illustration) and load-carrying capacity for a non-rotating journal with a reciprocating load.



Fairbanks, Morse *presents:*

the amazing

F-M HEAVY DUTY *Rotary Compressor*

- *Capacity up to 20,000 CFM*
- *Compression ratios up to 5:1 per stage*

Fewer wearing parts mean *Freedom from Shutdowns!*

- Rotors revolve without touching each other . . . or housing walls! . . . Vital parts and efficiency are maintained!
- It's S-M-O-O-T-H . . . no loosening of foundations or connections!
- Combines the best of both centrifugal and reciprocating compressors.

Oil Free Delivery! High Efficiency* Compression with low HP *reduces Operation Costs!

- The F-M Heavy Duty Compressor uses less horsepower to achieve compression ratios up to 5:1 per stage than either a centrifugal or other available rotary compressors!
- *Care-Free* F-M Compressor requires no internal lubrication . . . provides *Oil-Free* compression.

It's Compact . . . uses less floor space!

- Other compressors cost *more* because of increased installation and maintenance costs!
- F-M's heavy duty compressor weighs less . . . uses lower cost foundations.
- Less floor space increases your plant operating efficiencies.

F-M's Compressor is surge-free because of *Positive Action Design!* No pistons, valves, reciprocating parts!

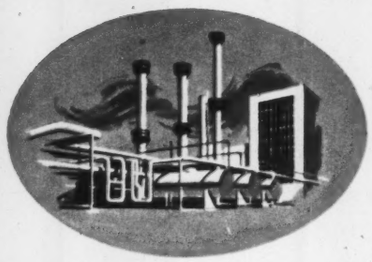
- Helical shaped rotors compress air or gas smoothly with high over-all economy.
- Axial compression occurs with the meshing of the male rotor lobes and the female rotor lobes. Discharge of compressed air or gas from successive interlobal cavities overlap resulting in *steady delivery, minimum vibration.*

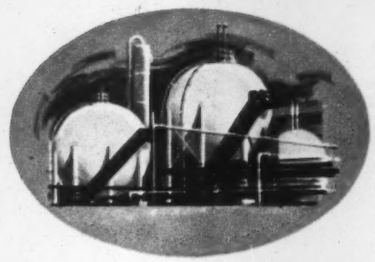
A Proved Way to Prevent Mechanical Breakdowns and Shutdowns!

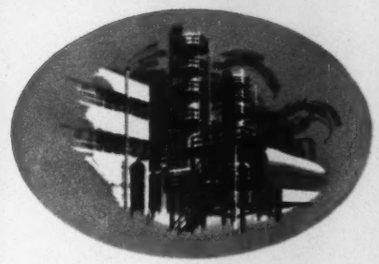
F-M HEAVY-DUTY COMPRESSORS HAVE BEEN THOROUGHLY PROVED IN MAJOR INDUSTRIAL INSTALLATIONS . . HERE AND ABROAD **PLEASE TURN PAGE**

"Production Downtime!"

Join Our "Who's Who" of F-M Compressors Users...







Orders filled or at hand for the unique Fairbanks, Morse Rotary Compressor read like a "Who's Who" of world-wide industry. You'll recognize them instantly! We'll make the list available on request.

Only F-M's Rotary Compressor gives you . . .

Continuous trouble free operation. • Less wear. • Fewer replacements. • Smooth, surge-free compression. • Highest efficiency of any rotating compressor. • Minimum floor space requirements. • Oil-free compression. • Minimum foundation costs. • No pistons, valves, reciprocating parts to wear. • No metal-to-metal contact in compression chamber. • No internal lubrication. • Pressure, vacuum or combination operation. • Minimum vibration, fewer repairs. • Less costly to install, operate and maintain. • Maximum mechanical simplicity. • Adaptable as portable or skid type unit. • High compression ratios.

The F-M Compressor . . . a *Versatile Asset* to Any Operation! F-M Rotary Compressors are available as single-stage units ranging in capacities from 800 to 20,000 cfm, for compression ratios from 1.6:1 to 5.0:1. Also for multi-stage or booster service at maximum working pressures up to 250 psig.

The F-M Compressor . . . a *Valuable Asset* to Any Operation! Chemical Processors—manufacturers of ammonia, ammonium nitrate, hydrogen peroxide, chlorine, ethylene, butadiene, acids, phenol, formaldehyde, and other chemical products requiring the compression of air or gas.

General Uses . . . Pressure and vacuum systems, process refrigeration, gas and vapor recycle service, production of yeast, tonnage oxygen, fertilizer. Catalytic cracking operations, fermentation processes, vapor recovery systems, aeration and agitation with air or gas. (This is by no means a complete list of uses . . .)

For More Information . . . send for your copy of our latest technical literature. It includes full details about today's most talked-about compressor . . . the F-M Rotary Compressor.

Tear Out This Advertisement . . . It's perforated for easy removal, office routing or filing. *Let's face it*—much equipment in the chemical, processing and mass-production industries is "here today, scrapped tomorrow"—obsolete long before it wears out. Be prepared for this eventuality. Start thinking about the Fairbanks, Morse Heavy-D[illegible]otary Compressor . . . now!

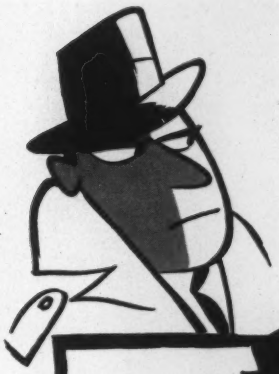
Fairbanks, Morse & Co.

600 South Michigan Avenue, Chicago 5, Illinois

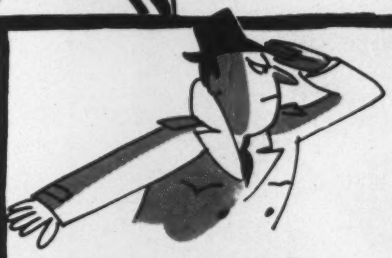
A MAJOR INDUSTRIAL COMPONENT OF FAIRBANKS WHITNEY CORPORATION, NEW YORK

ACOB 100.3

Printed in U. S. A.



HOW TO SLEUTH OUT THE TRUTH ABOUT EXPANSION JOINTS



1 **Case the joint (design, that is)**

Badger S-R Expansion Joints have: 1. Corrugations which assume "all curve" shape under pressure — low stress, long life. 2. Tubular rings allow flexing over more of corrugation height.

2 **"Weigh" the evidence**

S-R Joints have no bulky castings . . . weigh up to 50% less . . . diameter equivalent to pipe flange. Installation is easier, lighter supports required.

3 **Search for clues in fabrication methods**

Bellows are hydraulically formed to produce uniform corrugations with minimum thinning of material. Quality controlled longitudinal welding, no multiple circumferential welds.

4 **Remember to look for accessories**

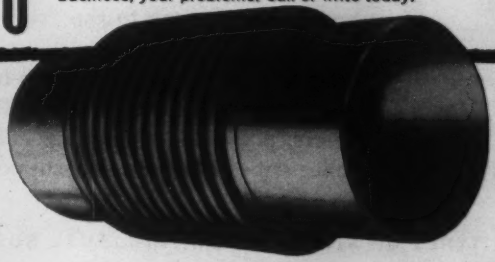
Full line of accessories — including covers and liners. Easy to pick proper combination of model, type and accessories for any pressure, temperature, erosive or corrosive condition.

5 **Pull an M.O. on the manufacturer's background**

Badger's 50-year experience includes development of first successful self-equalizing design for higher pressures, temperatures. Badger has had more fabrication and engineering experience in more different applications than any other manufacturer.

6 **Close the case — buzz Badger**

See the Badgerman for expert help on your most exacting pipe expansion problems. He knows his business, your problems. Call or write today.



BADGER *Expansion Joints* **S·R**

BADGER MANUFACTURING COMPANY
230 Bent Street, Cambridge 41, Mass.
Representatives in Principal Cities

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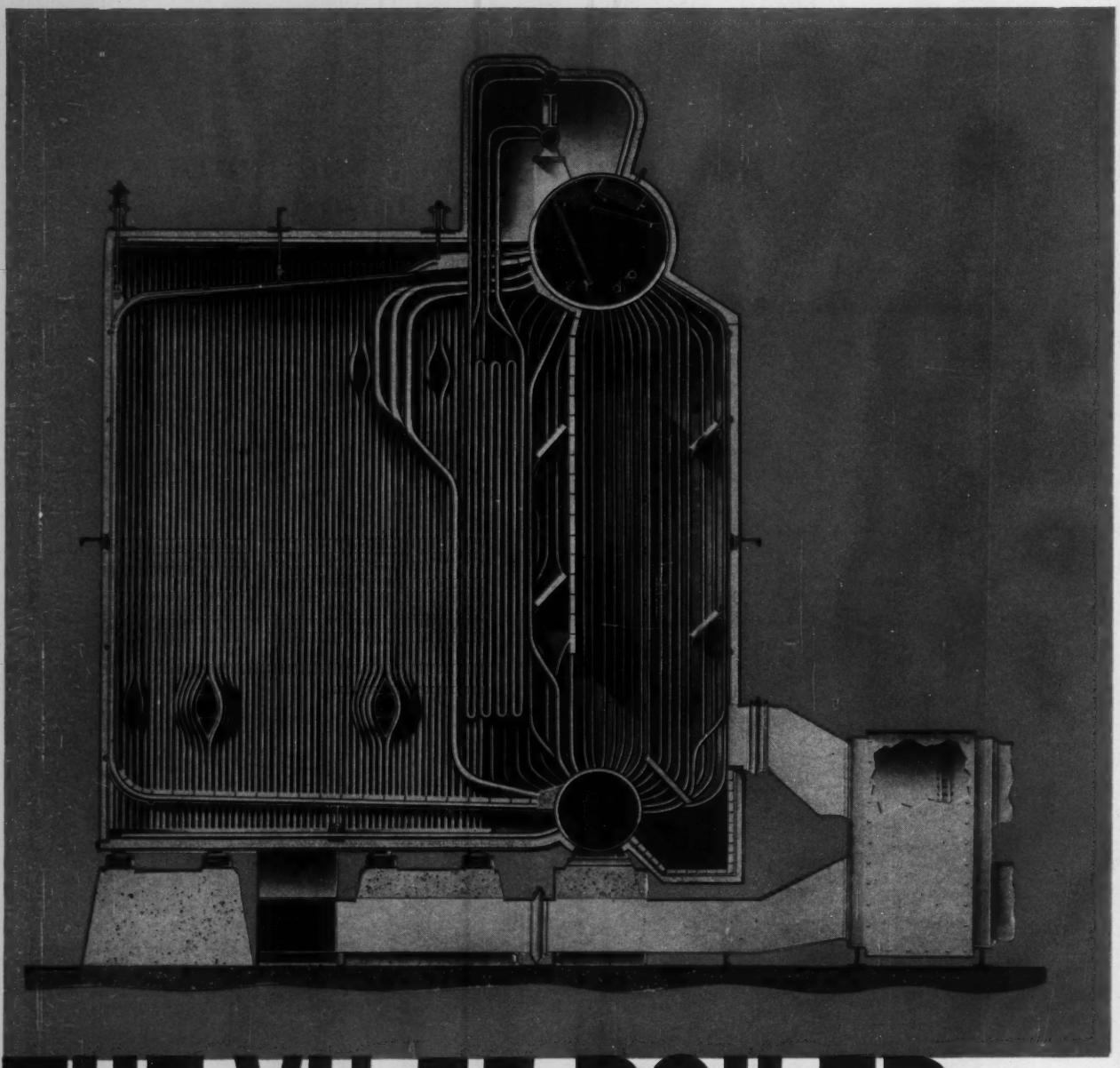


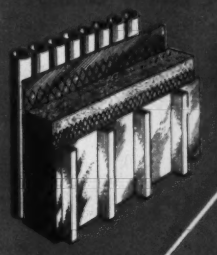
THE VU-55 BOILER...

The C-E Vertical-Unit Boiler, Type VU-55, is designed to bring central station type of performance to the "standardized" boiler market.

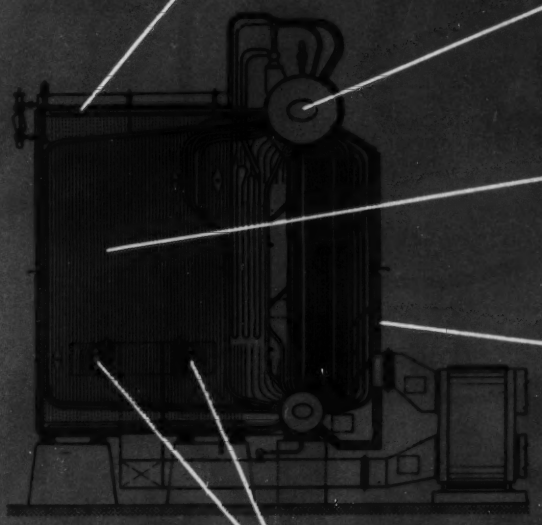
It combines a number of time-tested and service-proved features such as Tangential Burners, pressure-tight casing and tangent furnace tubes. This bottom-supported unit requires no outside supporting steel, is economical of space and has an uncluttered, streamlined appearance.

The VU-55 is available from 70,000 to 150,000 lb of steam per hour. It is designed for three pressure ranges (250, 500 and 750 psi) and can be equipped with a superheater to provide temperatures up to 800 F.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;



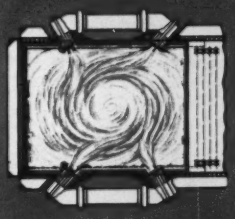
PRESSURE-TIGHT, SKIN CASING. A service-proved method of casing construction for pressure-fired boilers in the size class of the VU-55, this casing is designed to assure life-time tightness with minimum heat loss. Pressure firing permits the elimination of an induced draft fan with its attendant operating and maintenance costs. Wall construction consists of tangent tubes backed up successively with welded steel panels, 4 inches of high quality insulating material and an outer steel casing formed as shown to provide adequately for expansion and to give a neat, finished appearance.



HIGH STEAM QUALITY. The VU-55 has generous water capacity and steam reservoir space. Its drum internals are exceptionally effective in producing high quality steam at all ratings.

TANGENT FURNACE TUBES. The VU-55's furnace tube arrangement provides complete heat-absorbing, water-cooled protection on all furnace walls. Furnace maintenance is minimized, refractory expense is eliminated.

STREAMLINED EXTERIOR. The over-all appearance of the VU-55 reflects the efforts of its designers to achieve a completely unobstructed casing, while retaining adequate access wherever required and every facility for convenient operation. There are no outside downcomer tubes, and the ducts from air heater to burners are beneath the furnace floor.



TANGENTIAL FIRING. More than 20 years of application experience have established the exceptional advantages of tangential firing. About 90 percent of Combustion's large utility installations use this advanced method of firing. Flame streams from the four burners impinge upon one another at high velocity, as shown, creating a turbulence unattainable by any other method of firing. The result is rapid and complete combustion. As the gases spiral upward, they sweep all furnace heating surfaces, assuring a high rate of heat absorption.

a "standardized" boiler with "custom-built" performance

The unit is symmetrical in design, performs efficiently over a wide range of output, and is exceptionally easy to operate and maintain.

When you are considering additional steam capacity in the quantity range mentioned above don't fail to investigate the advantages of the VU-55.

COMBUSTION ENGINEERING

C-E

C-261

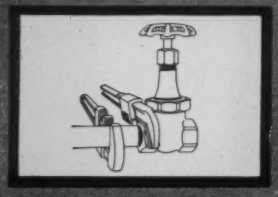
Combustion Engineering Building
200 Madison Avenue, New York 16, N. Y.
Canada: Combustion Engineering-Superheater Ltd.

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

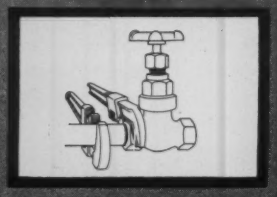
Here's How KENNEDY'S Union Bonnet and Hex End Design Give You Easier Installation, Longer Valve Life...

Fig. 525

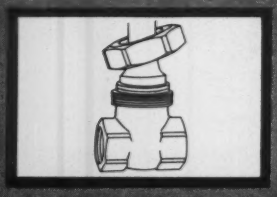
Fig. 525
125-Pound SWP Bronze Gate Valve
Union Bonnet - Rising Stem - Inside Screw - Wedge Disc



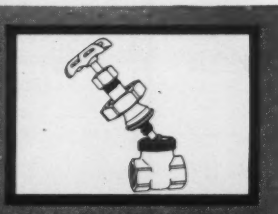
KENNEDY'S wider hex ends are blended into the body, making the body and hexes one rugged unit. Thus extreme wrench pressure is absorbed through the entire rigid valve body.



On conventional valve body, hex ends protrude from the body and are connected by thin body wrists. This area, under severe wrench pressure, can distort and cause disc seating trouble.



Kennedy's Union Bonnet permits repeated dismantling for cleaning or inspection and reassembly without danger of distortion to the valve. The bronze-to-bronze construction makes a tight union for tight, leak-proof operation.



Union Bonnet Fig. 525 can be easily disassembled into its component parts to installation in otherwise inaccessable places in existing lines or in new installations where space is limited.

These additional advantages make KENNEDY your best valve buy ...

Heavy Bronze Union Bonnet Ring is entirely separate from the bonnet to eliminate any possibility of springing the bonnet face when assembling or disassembling the valve.

Cylindrical Body withstands sudden pressure. Kennedy's Cylindrical Body construction resists rupture and minimizes deflection when under severe pressure. Pressure in ordinary valve bodies tries to push the body wall out. Rupturing stresses concentrate where wall has the shortest radius. This deflection causes early failure in ordinary valves.

• *YOU CAN'T BUY A BETTER VALVE THAN A KENNEDY!*

KENNEDY VALVE MFG. CO.
ELMIRA, NEW YORK

VALVES • PIPE FITTINGS • FIRE HYDRANTS

• OFFICES AND WAREHOUSES IN NEW YORK, CHICAGO, SEATTLE, SAN FRANCISCO, ATLANTA • SALES REPRESENTATIVES IN PRINCIPAL CITIES •

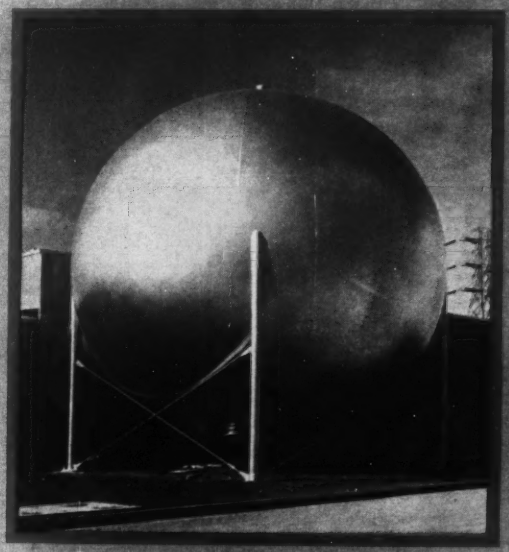
HORTONSPHERE
helps advance missile technology

The flight of a ballistic missile entering the earth's atmosphere is simulated in an Atmosphere Entry Simulator built by the National Aeronautics and Space Administration at Ames Research Center, Moffett Field, California.

Employing the Ames Simulator, space scientists quickly and economically determine in the laboratory whether a specific design can survive re-entry.

CB&I fabricated and erected several vital components for this important research facility. Included are a 30½ ft. diameter steel vacuum sphere and a 10 ft. diameter duct and elbow.

Craftsmanship in Steel—skillfully developed by CB&I over more than seven decades—builds quality into plate structures for any kind of service. You will profit by contacting our nearest office for full details.



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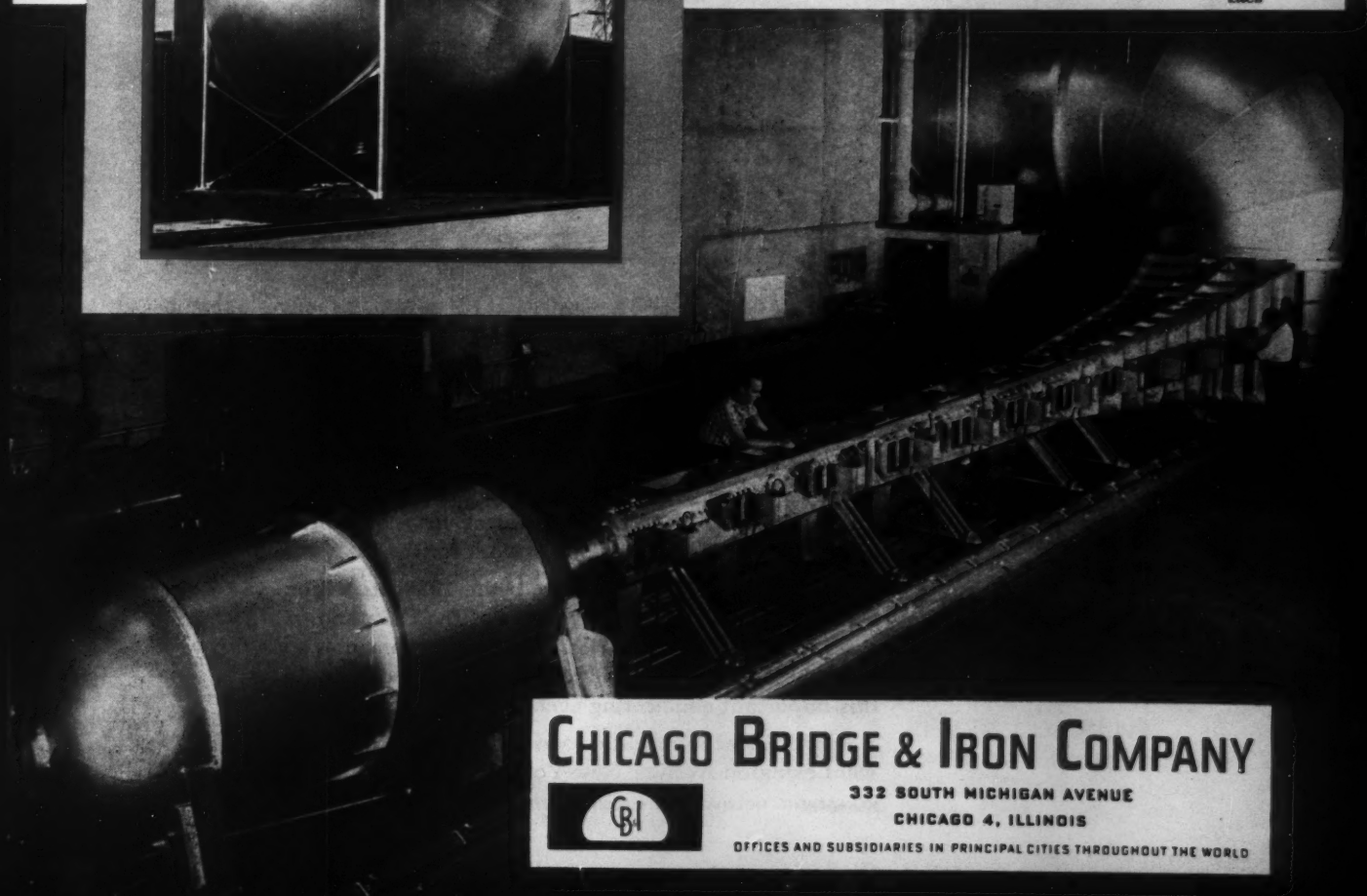

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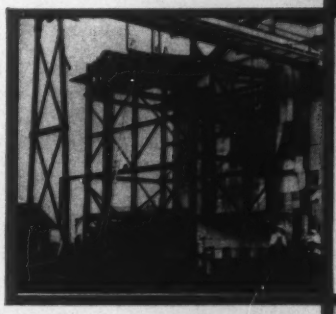

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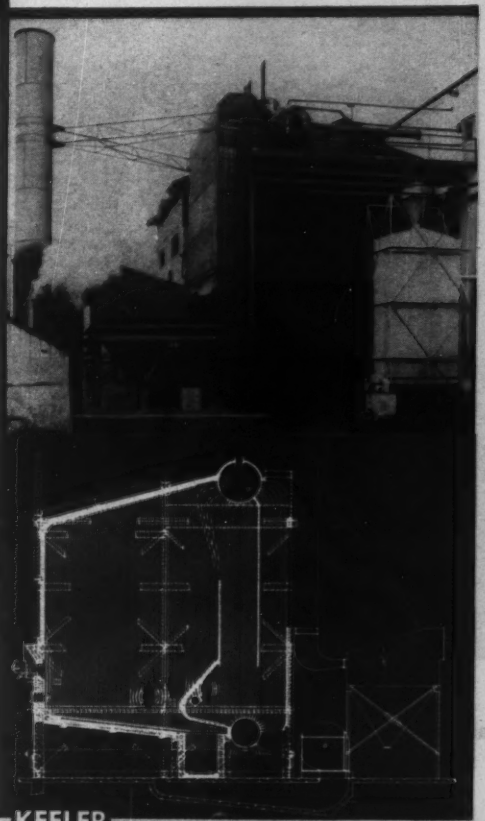

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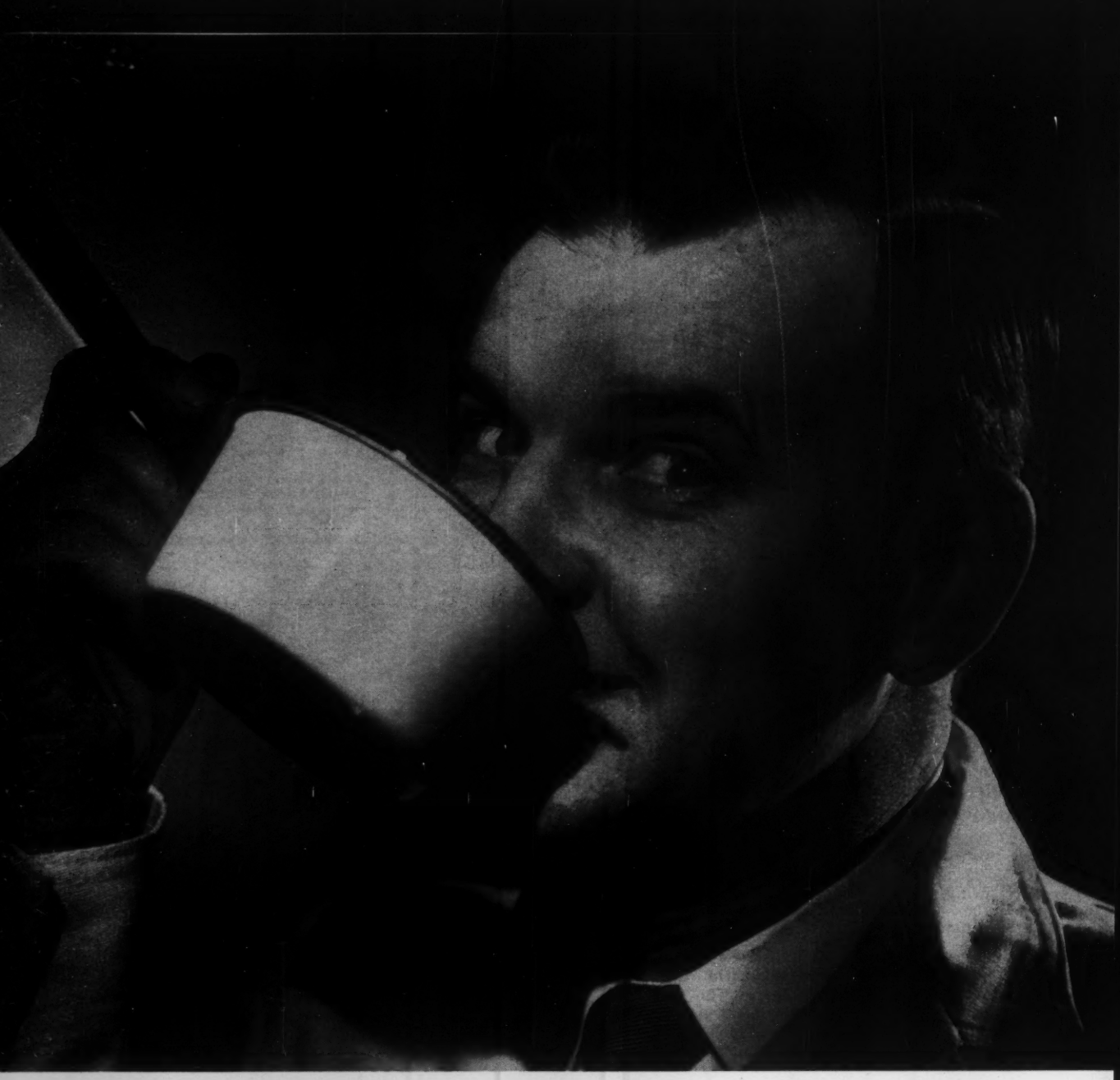

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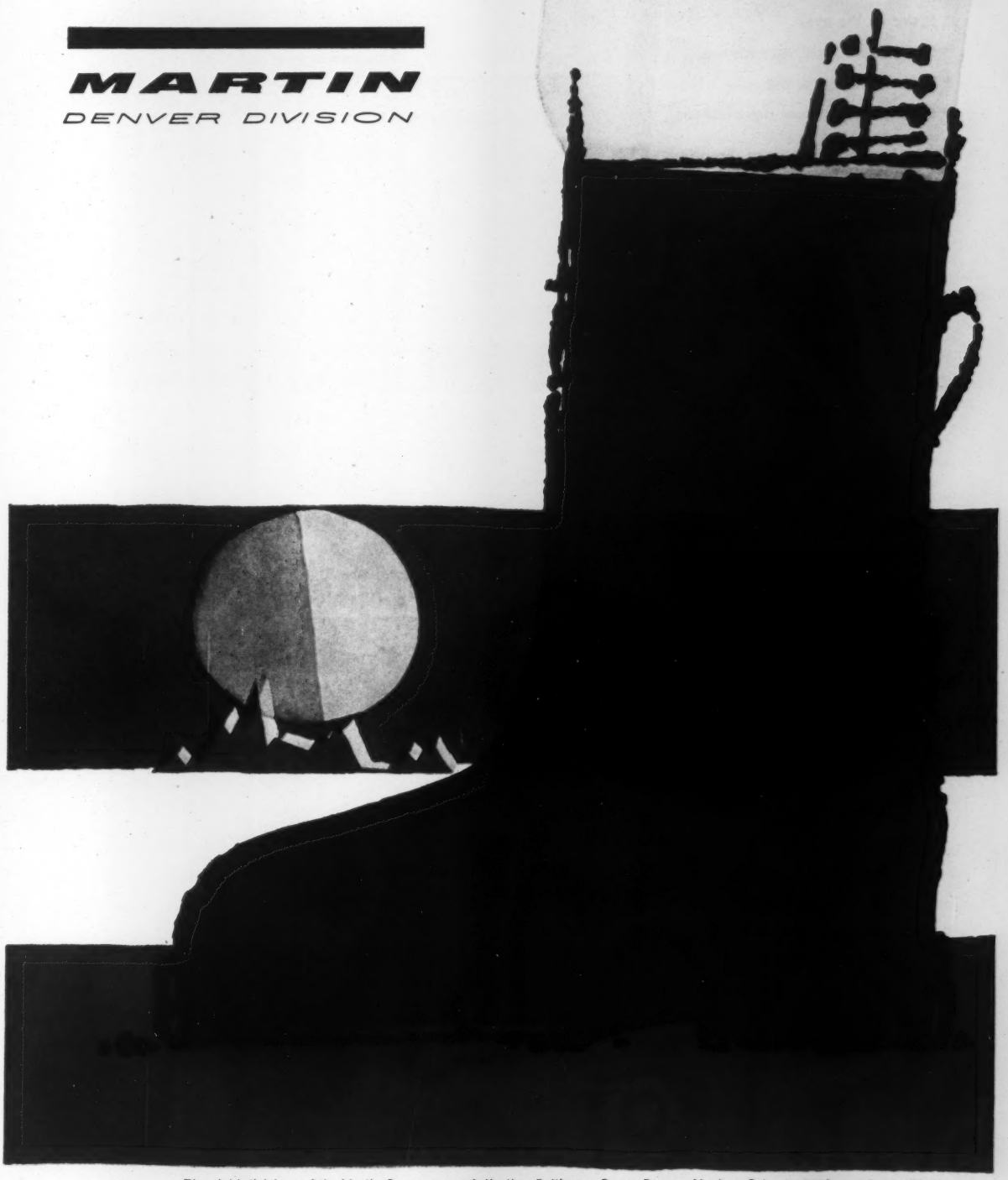

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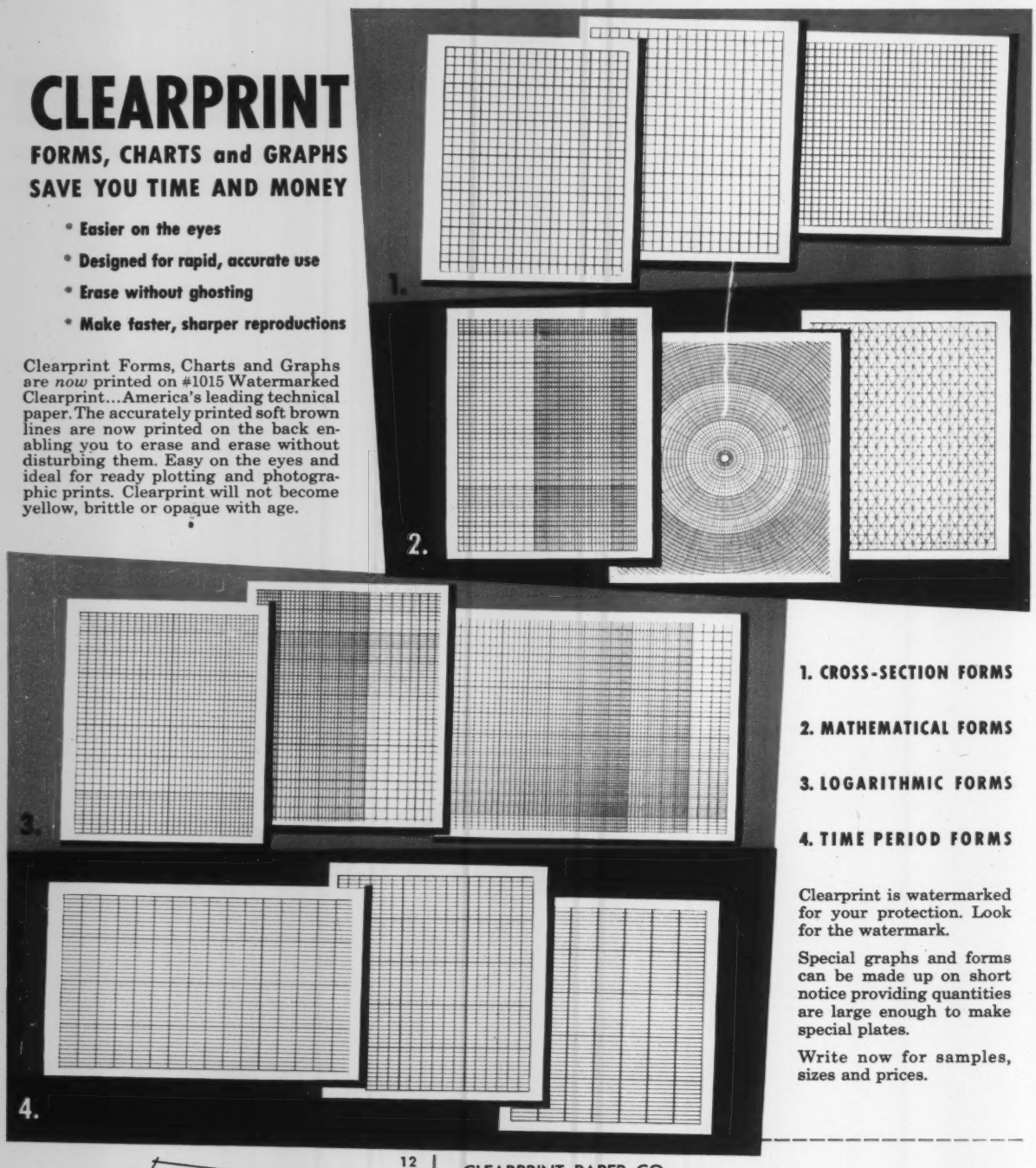

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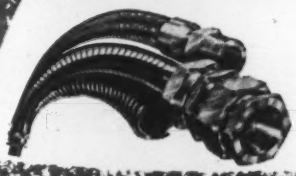

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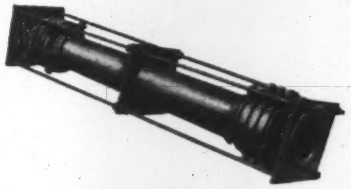

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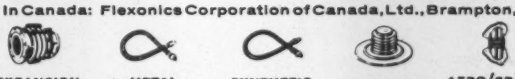

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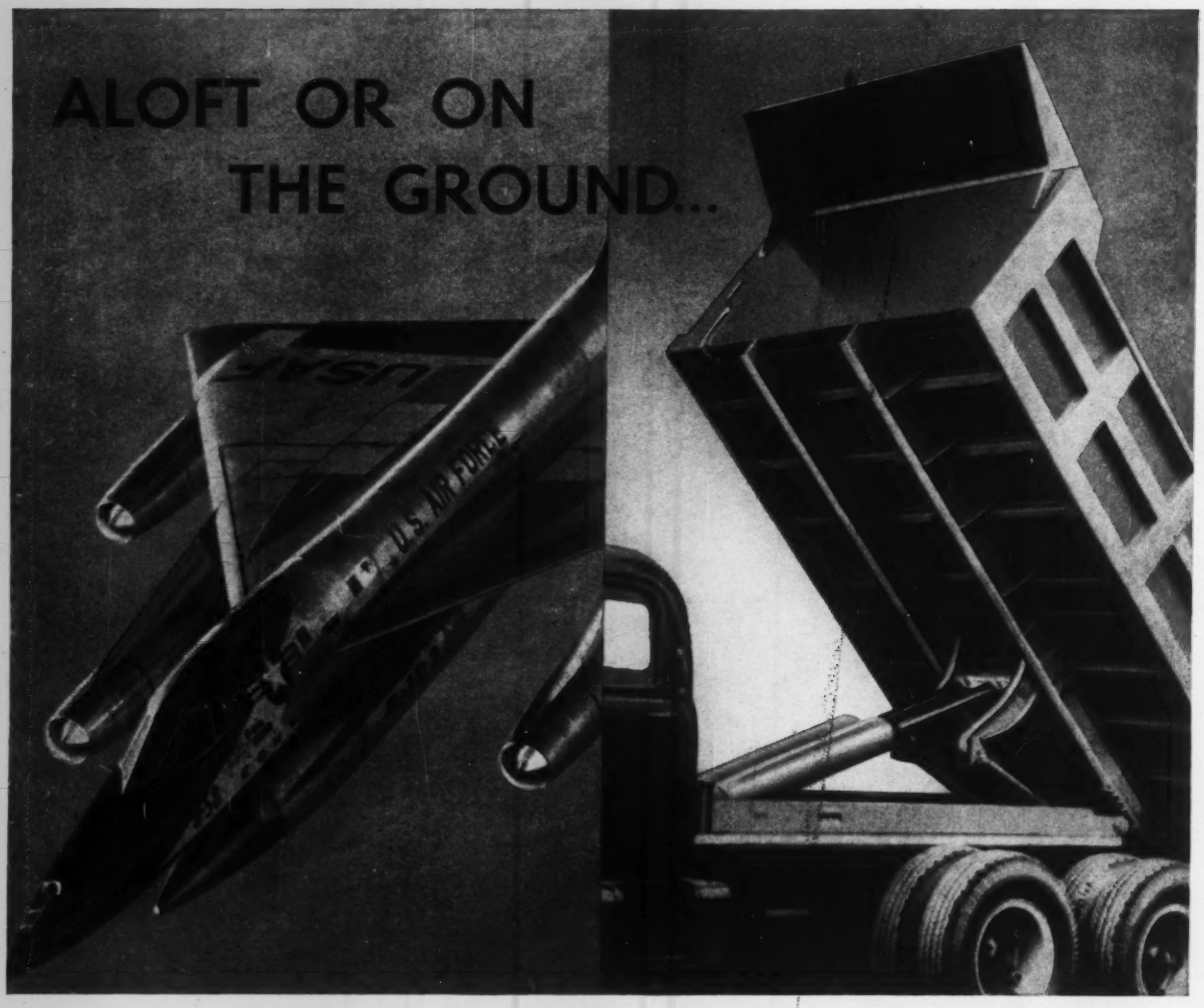

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MECHANICAL ENGINEERING

VOLUME 82 • NUMBER 5 • MAY, 1960

Design Engineering

The big topic of interest later this month will be design engineering when the ASME Design Engineering Conference and concurrent Design Engineering Show are held in the New York Coliseum, May 23 to 26. And to give ASME members some idea of what they can expect at the Coliseum, two special sections in this issue are devoted to both the Conference and the Show.

In the feature section, pages 39–53, a group of selected articles based on papers to be presented at the Conference deal with up-to-the-minute design problems and developments. They cover automatic assembly, the use of standard hydraulic components, welding processes, and explosive forming. The full range of topics to be discussed at the four-day meeting, which is sponsored by the ASME Machine Design Division, will include: A panel discussion on new horizons in engineering; sessions on reliability predictions and requirements in equipment specification, new developments in joining and forming metal parts, hydraulic components to meet the requirements of extreme pressures and temperatures, design of control systems, high-strength materials, and automation; and a general engineering session on where and how to use computers.

All technical sessions will be held in the morning so as not to conflict with the show which will be open each day from noon.

In addition to the design feature section, a special Design Conference and Show insert, pages 139–146, includes the conference program, digests of technical papers to be presented, exhibit floor plans, and a list of exhibitors.

At the Design Engineering Show, which is produced by Clapp & Poliak, Inc., of New York City, the visitor will have the opportunity to see first-hand, in one place, at one time, new products and developments from some 400 manufacturers: Products in action, working models, cutaways, technical illustrations, many actual and potential applications.

The inquisitive engineer will be able to obtain factual product stories and design solutions quickly and easily. Exhibitors' engineers will be on hand to discuss fully any design problems. A host of demonstrations, applications, and suggestions to improve product performance and sales appeal, reduce costs, increase production, and broaden markets will be offered to the visitor on all four floors of the Coliseum.

He will be able to conduct performance tests on the spot, check competitive claims—by going from booth to booth. Samples will also be available for testing and trying out back at the plant.

Product categories at the show will include: Mechanical components, power transmission equipment, electrical and electronic components, metals, nonmetallic materials, fasteners and adhesives, finishes and coatings, shapes and forms, hydraulic and pneumatic components, and engineering equipment, services, and publications.

In all, about 15,000 products, which go into the making of end products, will be shown.

For engineers who create new products, redesign existing ones, or supervise those who do, a visit to the Design Engineering Conference and Show will prove to be of inestimable value. Once again, the dates: May 23–26, 1960; the place: New York Coliseum.—*J. J. Jaklitsch, Jr.*

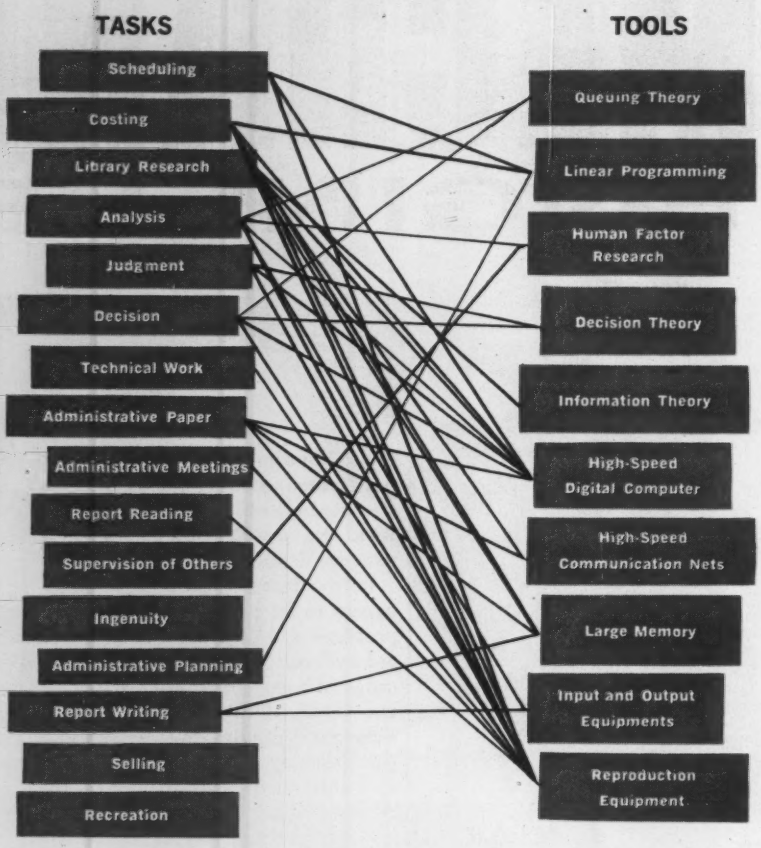
Editor, J. J. JAKLITSCH, JR.

DECONTROL THE ENGINEER?

It is time to consider how the engineer's routines can be reduced, allowing more time for engineering

By H. H. Goode[1]

University of Michigan, Ann Arbor, Mich.



In setting out the problem of engineering decontrol, the arguments are simple: The amount of engineering we must achieve per engineer is increasing; it is possible to provide more engineering per engineer; parts of the present engineering job can be reduced; the tools are available for simplifying the task.

The amount of engineering required by society will depend on the complexity of the mode of living which, in turn, is largely measured by the number of contacts of man with man. As the population increases, life becomes more complex. Population, by its very nature, increases exponentially.

On the other hand, the portion of our effort as a society devoted to engineering has not increased exponentially. Thus, in Fig. 1, we see an almost exactly linear trend in the fraction of manpower devoted to engineering from the period 1900 through the period 1940. At this point there is a rise which is partially real due to the increasing emphasis on automaticity, and partially fallacious due to the inclusion among engineers of people who were not so considered before 1940. Since, by the 1957 estimate, we are already devoting three out of every thousand people to engineering, it is hard to see how the society may afford a much greater proportion in the engineering profession without becoming completely lopsided. Moreover, it is seriously questionable as to whether a greater fraction of the population can be advantageously trained in engineering.

The Point in Question

We need to show first that there are parts of the engineering job which can be done more efficiently either by having the engineer do it in an easier and better fashion or by having something other than the engineer (e.g., a machine) take on the job. Also, we must show that the wherewithal in theory and machines is available to do just that.

To get more engineering per engineering hour, we must make inroads into those portions of the engineer's job which are not creative in the engineering sense. The engineer himself, either through habit or through natural inclination, tends to emphasize the routine portions of his job at the expense of the creative portions. To some extent we encourage the engineer to blow up those aspects of his job which are routine and discourage him from creativity and planning.

A routine job is usually found for the starting engineer. After two to three years, during which he has probably been told, "You can forget those highfalutin' tools they taught you in school and get down to some engineering, my boy," he enters upon the main engineering task, which he now conceives as being made up of sets of routines. Having been started along this direction, he

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[1] Electrical Engineering Department.

Contributed by the Management Division of The American Society of Mechanical Engineers and presented at the ASME-AIEE Engineering Management Conference, Los Angeles, Calif., September 17-18, 1959. ASME Paper No. 59—Mgt-2.

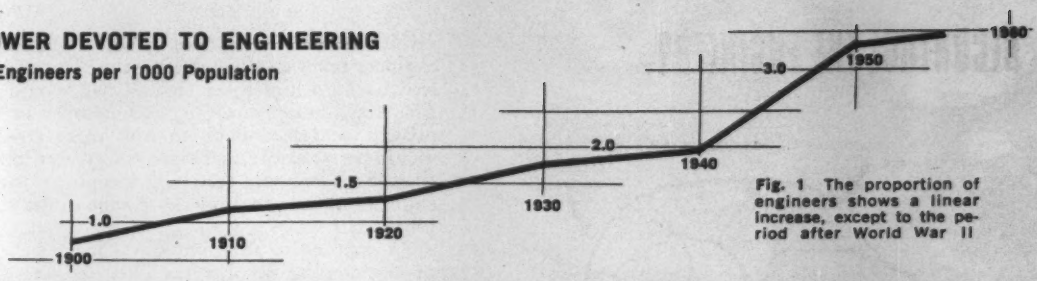

Fig. 1 The proportion of engineers shows a linear increase, except to the period after World War II

begins building a structure made up of routines. By the time he has become an engineering manager, it is difficult for him to conceive of the engineering task being carried out in any other fashion.

New Tools

During the past 15 years there has been a veritable revolution in the development of new theoretical tools as well as new equipment, all of which have contributed to the overturn of the "standard" method of doing things. Examples are:

Linear Programming. A technique for solving sets of inequalities which may be limiting conditions on the problem. The chemical engineers will have encountered it in connection with blending in gasoline. Transportation engineers will have encountered it in connection with routing problems. Communication engineers will possibly be familiar with it in connection with message traffic allowable over various types of communication facilities. As a technique applicable to the parts of the engineer's job, it will make deep inroads into the scheduling aspect of his job, into the costing aspect of his job, and may possibly aid in his administrative planning function.

Queueing Theory. A technique which allows the analysis of events in terms of the times it takes them to occur, rather than in terms of the actual function being performed. It gives answers to questions concerning the number of channels of flow which are necessary for a given job, and amounts of traffic which can be handled, the times it will be necessary for customers to wait, the rates at which equipments will deteriorate. It will aid the engineer both in his analysis function and in his function of decision making.

Human-Factors Research. This is the fitting of the man to the machine in our machine age. It concerns itself with three major questions: Physically, what shape and form should equipments take to be matched to human beings? Logically, how does a human best fit into a system and which of his functions is best suited to mechanization (whether from an administrative or a design standpoint)? In training, how can we best train humans to do the work of our highly mechanized living?

The engineer's job will be affected by the results in this area in two ways: Designwise, that is analytically, he will be aided in the solutions that he evolves for engineering problems; administratively, its results will affect how people are used under him when he is an engineering manager, or when assisting him as an engineer.

Decision Theory. This will have a more far-reaching effect than the others, particularly in the judgment and decision-making aspect of the engineer's job. One aspect of decision theory breaks the problem down, roughly speaking, as follows: Associated with every decision is the situation as it was prior to a search for more information. If a decision were to be made at that point, it would be on the basis of *a priori* probabilities, unaffected by what further information could be gathered. To actually make a decision, one proceeds to gather information. This information succeeds in furnishing new estimates of the probability of one or another alternative being the correct one. If one adds to the *a priori* probabilities, and the *a posteriori* probabilities, the costs and utilities of making each of the possible judgments, he has drawn into the situation all of the essential elements in the making of the decision itself. This has had great impact in the communications area in the actual implementation of equipment, and is beginning to have larger implications in all decision making.

Information Theory. This has given us a model which allows us to estimate quantitatively the amount of information contained in a fixed storage, the amount flowing over a channel of communication, and the amount taken in by receptors, as for example the human eyes, or a radar. Information, mass, and energy have become the three fundamental quantities as opposed to only mass and energy up until about 10 or 15 years ago. While information theory will have far-reaching effects over the entire engineering job, specifically it will affect the library-research function directly.

Along with these and other analytic tools which have been developing over these years, a revolution has taken place in equipment. Foremost among these developments is the high-speed digital computer which has so affected every aspect of today's living. The computer will directly affect scheduling, costing, library research, analysis, decision making and judgment, as well as paper administration.

It is not the computer alone that is affecting this revolution. There are other equipments coming into play which have had effects complementary to the computer, and with great impact. High-speed communication nets, for example, are major contributors to this revolution. The ability of one organization to talk to another in the sense of high-speed flow of information between them, on an immediate basis, is itself a major change in the conduct of business and will affect engineering directly. Not only can one person in an organization talk rapidly to another, but one computer in an organization will be able to talk rapidly to another computer in the same organization, or in others.

The computer memory itself is worthy of note as a contribution to our modern complex. Memories in computers are beginning to run up to 10^6–10^7 words, at least in the planning. But we are talking of large memories of the order of 10^9–10^{10} words. Such large memories on a random access basis, or consultable in blocks, have a tremendous effect on the over-all conduct of society's affairs. But, in particular, they will affect the engineer's job. The effect here will be in costing, in library research, in paper administration, and in re-

DECONTROL THE ENGINEER?

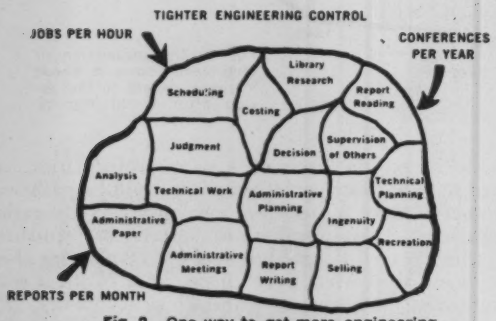

Fig. 2 One way to get more engineering per engineer: Tighten the controls, drive the engineer harder.

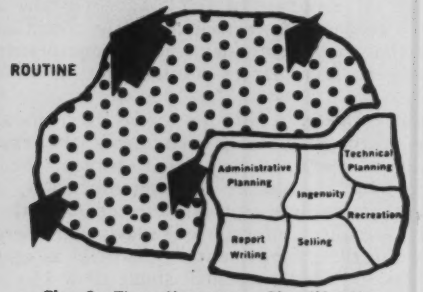

Fig. 3 The other way: Simplify the engineer's task, and allow greater time for the higher engineering functions of ingenuity and planning.

porting. The memory itself makes it possible to store and retrieve (which is the more difficult portion of the task) large amounts of information which previously have been stored but were not retrievable—not with certainty, at the right time.

Input and Output Equipment. These, of themselves, are having an effect on all of the areas, both in the general conduct of business affairs and in the engineering function. The high-speed printer is capable of exhibiting a tremendous amount of information in a short time. The oscilloscopic display makes it possible to put out engineering curves and to examine these curves in a rapid fashion, thus cutting the times for analysis by factors of a hundred. The fact that original records are being made on machines and inserted into the data-processing system, allowing their automatic treatment thereafter (as opposed to reduction at the computer into an automatic language), will have a considerable effect on the way in which engineering is carried out in the future. Finally, devices capable of fast reproduction throughout the system of information records, whether these be drawings, written material, calculations, and so forth, will act as a lubricant for all of the engineering functions.

Control: Or Decontrol?

There are two diametrically opposed approaches to the problem of achieving more engineering per engineer. On the one hand, one may seek to "control" more rigidly the engineering process. As shown in Fig. 2, this would imply measuring, on a more detailed and more rigid basis, the output of the engineer in all of his tasks in a given period. We would measure the time that the engineer takes to schedule, the time he takes to cost, and feed back to him these times. We would measure the time for library research, and number of jobs accomplished, and feed back to him these statements. We would press, cajole, and argue for greater output.a But in so doing, we would be trying to squeeze down the entire engineering job, making no change in the content of the job itself.

As opposed to this, we may consider the desirability of engineering decontrol. This amounts to removing some of the tasks from the picture, as shown in Fig. 3, and allowing the higher engineering functions of ingenuity, of planning, to occupy a greater space in engineering time. By placing our efforts on the removal of the routine job, we exhibit our faith that the engineer truly is an engineer and will expand into the space made available to him with an exhibition of greater ingenuity.

In the chart at the beginning of this article, we have lined up on the left all of the various functions which the engineer performs, and on the right have listed the tools. We have drawn lines to show the effects which the right-hand tools will have upon the left-hand job. Clearly, if the jobs in the upper portion of the figure can be reduced or eliminated, then there is more time, more engineering time that is, to perform the higher engineering functions.

A Word of Warning

Some cautions are necessary concerning the validity of the arguments proposed. There is not too much doubt concerning the validity of the argument that we need more engineering per engineer. This is true, whether it is based on the requirements of the society, or the society can be sold the additional available engineering, or whether mere increases in productivity are desirable.

There is no doubt either that a large proportion of the engineer's job is of a routine nature. But whether he actually would expand into greater available time with more creativity, or whether what he does during these routine periods is to ruminate over the problem, and whether his ingenuity is truly a product of all the routine plus the time in which he is being ingenious, is a serious open question. It is quite possible that, in giving to ideas as well as to people, shorter or longer times are not permissible, no matter how much or how little manpower is on the job.

It may be argued that certain members of the population are ingenious and certain others are not, and that the ingenious ones are so whether we provide them the time or not. The noninventive people are simply noninventive, no matter how much time is available to them for doing invention. But surely if there is a characteristic of human beings associated with creativity, then it is a continuum; that is, we can find all gradations of creativity if it could but be measured. Further, there is no doubt that creativity is affected by the conditions surrounding it. Individuals report their own greater creativity under one set of circumstances as opposed to another. If this is true, then changing the structure and conditions of the engineering job will increase everybody's creativity somewhat, leading to a greater yield of engineering per engineering man.

We still have not shown that the tools presented truly do take over the routine in a satisfactory fashion so as to save either money or time. It is believed that they do, but time will demonstrate.

The designer of today's machinery needs an understanding of many new methods and techniques. Among them: Automatic assembly, and the wise use of hydraulics. He must anticipate the methods by which parts will be formed, from welding to explosive forming.

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Robert Esken
Sheffield Corporation

2 WELDING PROCESSES
John J. Chyle
A. O. Smith Corporation

3 FABRICATION BY EXPLOSIVES
Vasil Philipchuk
American Potash and
Chemical Corporation

4 HYDRAULICS: STANDARD COMPONENTS
Edward I. Brown
Vickers Incorporated

DECONTROL THE ENGINEER?

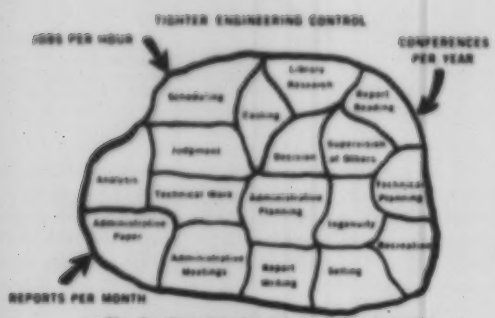

Fig. 2 One way to get more engineering per engineer: Tighten the controls, drive the engineer harder.

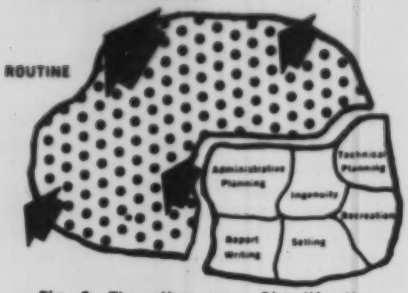

Fig. 3 The other way: Simplify the engineer's task, and allow greater time for the higher engineering functions of ingenuity and planning.

porting. The memory itself makes it possible to store and retrieve (which is the more difficult portion of the task) large amounts of information which previously have been stored but were not retrievable—not with certainty, at the right time.

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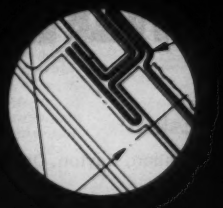

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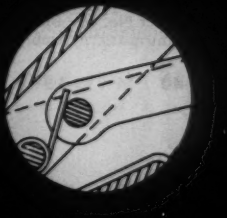
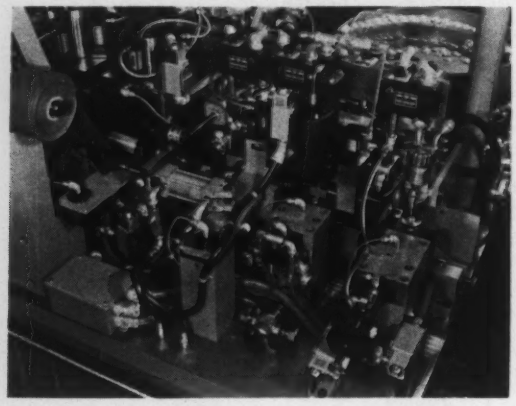


DESIGN ENGINEERING

You have to know the extra features a part will need for automatic handling and assembly. Where do you need "locating surfaces"? Should assembly be by screws, rivets, snap rings? Here are points of design.

AUTOMATIC ASSEMBLY



By Robert Esken[1]
Sheffield Corporation, Dayton, Ohio.

AUTOMATIC assembly is becoming increasingly important in industry since it: (*a*) Eliminates the need to use human beings in dull repetitive operations; (*b*) improves product quality; (*c*) increases production; (*d*) saves space; (*e*) decreases cost.

The degree to which automatic assembly can be used depends, in part, on the ability of the product designer to incorporate into the design of each component characteristics for mechanical conveying, feeding, positioning, and fitting.

The product designer has the power to make assembly operations simple or complex and frequently he must take into account factors that are not considered in designing for hand assembly. The cost of adding part characteristics necessary for automatic assembly will be outweighed by the large-scale economies of automatic assembly, resulting in a decrease in over-all manufacturing cost.

The efficiency of automatic-assembly machines depends on the laws of probability to a large degree. Hoppers, vibratory feeders, gravity chutes, and consistently fitting parts are but a few of the factors affected by probability which can be controlled by the product designer with some consideration to assembly methods.

Before attempting to design products for automatic assembly, some of the problems encountered must be understood. These can be summarized under part handling and product parameters.

[1] Supervisor-Autometrology.

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Part Handling

Manual, magazine, and automatic-feed systems are used to feed parts to automatic machines. The system to be used must be determined by several factors—production rate, cost, and the inherent characteristics of each component part. Often it is necessary to combine two or more systems in one machine.

Manual Feed. Manual feed generally is used with extremely large parts because these would be damaged if allowed to bump into one another in hoppers and feed chutes, and because the space requirement for the storage of large-size parts would become excessive.

Product design can help to improve manual feeding. To avoid the tediousness of thinking each time the worker places a part in a machine, and the accompanying drop in efficiency, part design for manual feed should feature some physical characteristic such as a protrusion, hole, or the like, to facilitate loading and orientation of the part.

Parts should be free of sharp edges and burrs to permit the worker to wear thin gloves or use bare hands, and the shape of the part should prevent entanglement when it is being picked out of the bin or tote box.

Magazine Feed. Machines operating at high speeds require magazine feed. The use of magazines permits loading to be at some distance from the machine, where a manual operation may be performed at a rate to keep pace with production. As would be expected, the same problems and solutions outlined for manual feed then apply to magazine feeding. Magazines can also be loaded as part of the manufacturing process as in the case of wire retaining rings where the wire is wound in a coil on a mandrel during manufacture. The coils are then sliced into individual rings and the mandrel becomes the

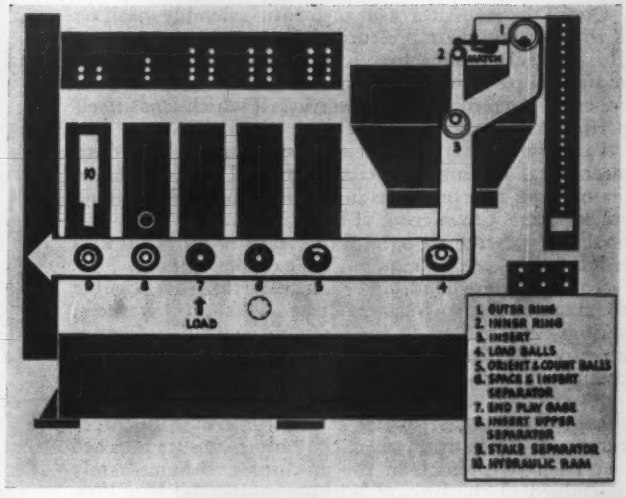

Fig. 1 The automatic assembly of ball bearings requires the fitting of three basic parts to close tolerances. Each of the 21 ball-bearing size groups is stored in individual hoppers and placed on the machine. Random-size inner and outer rings for the ball bearings are fed into the machine. The first station inspects both rings simultaneously, giving a composite-size reading from which the correct size of balls can be determined. Both rings are then conveyed to the assembly position where the selected group of balls is inserted.

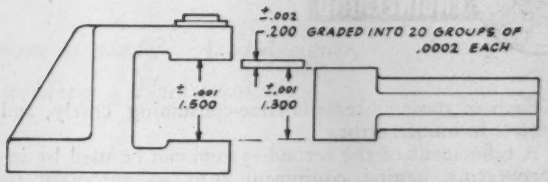

Fig. 2 The yoke and clevis assembly may possibly incorporate a single spacer, which can be manufactured very accurately to close tolerances and in a sufficient number of size groups to allow a wide manufacturing tolerance on the yoke and clevis and still result in a correctly fitted assembly

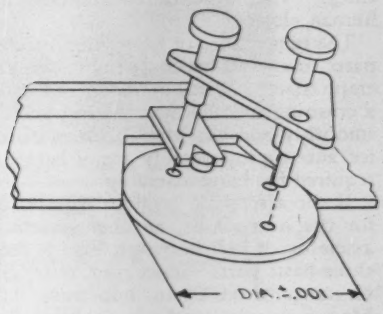

Fig. 3 The flat wafer required precise alignment for the assembly of pivot shafts. The location was obtained by adding a protrusion and holding the outside diameter to a closer tolerance.

magazine which is loaded directly into the assembly machine.

Thin stampings such as leaf springs, contact arms, gaskets, shims, and the like, can be stamped in continuous strip without separation. The strip is wound in a coil and the coil placed in the assembly machine which incorporates the mechanism for separation.

Automatic Feed. The optimum sought in all automatic-assembly machines is fully automatic operation of all of the equipment involved, including part feeding. Product design can dictate to a great degree the accomplishment of this goal. There are two systems for automatic feeding—part-feeding hoppers and conveying mechanisms. In many cases, both systems are used with one complementing the other.

The production rate required determined whether hopper feeding can be used. Although multiple hoppers can be used, experience indicates that the fewer there are the better the system. Hoppers can be loaded manually or supplied automatically from a bulk-storage hopper.

Devices used in part-feeding hoppers rely on the ability of a part to fall, position, or deposit itself in a given manner. The hopper engineer tries to determine the position each part is most likely to maintain. He then inserts devices into the system to eject all parts not maintaining position. Thus the law of probability determines the number of parts that will be fed properly oriented.

Product design can greatly improve hopper performance by providing such inherent characteristics for part feeding as off-center weight distribution, lugs, or slots. In the case of cylindrical parts, if the length is 25 per cent or more longer or shorter than its diameter, feeding efficiency is better.

Product Parameters

Exact duplication is required for automatic assembly. Production machines are now capable of giving results approaching exact duplication, but this will never be completely achieved because of the many variables encountered. Tool wear, machine-capability variations in materials, and temperature are a few of these variables, each of which can be minimized or even eliminated. However, this is a costly procedure which can make manufacturing costs prohibitive. The alternative is to design into a product the ability to accept the result of these variables without affecting product performance. Sometimes variability is controlled, instead, by the tolerance of the assembly mechanism.

The assembly of push buttons demonstrates this point clearly. The external dimensions of these buttons could vary widely without affecting performance or appearance, but precise alignment is required to assemble the buttons to the tuner shafts and this is obtained from the external surfaces of each button.

Gaging for Automatic Assembly

Applications do arise where the product cannot accept, to any great degree, these tolerance variables in the final assembly and at the same time it is not practical or economical to eliminate them in the manufacturing stage.

Under hand assembly, the worker fitted parts by trial and error until an assembly was obtained, or parts were custom-fitted by filing or forcing frequently to the detriment of product quality and performance.

The next step in the assembly evolution was to gage the dimensional size of individual parts, classify them into size groups, and selectively fit mating components.

Each of these systems is time-consuming, costly, and subject to human error.

A refinement of the second system can be used by incorporating gaging equipment into an automatic-assembly machine. This inspects each part as it enters. The second, or mating, parts are also gaged and classified and stored in racks or magazines at the assembly machine. As the random-size parts are inspected, a size signal is initiated that causes a proper-size mating part to be fed into assembly position from the storage racks or magazines. This system reduces cost and minimizes the human element.

The importance of supplying dimensionally acceptable parts to an automatic-assembly machine cannot be overemphasized. Without them, the machine will come to a crashing halt because mating parts won't fit together smoothly and quickly. Thus it is axiomatic that parts for automatic assembly are of better quality than those required for hand assembly.

If the assembled product requires three or more parts for the over-all fit, another system can be used. The assembly of ball bearings, Fig. 1, requires the fitting of three basic parts—inner ring, outer ring, and balls—to a clearance of 0.0004 in. minimum, 0.0008 in. maximum. Manufacturing methods prohibit holding size on the rings to a size tolerance of less than ±0.001 in. The balls lend themselves to controlled size within ±0.000025 in. permitting manufacture of 21 size groups with 0.000050 in. between groups. Each group is stored in individual hoppers and placed on the machine. Random-size inner and outer rings are fed into the machine. The first station inspects both rings simultaneously, giving a composite-size reading from which the correct-size group of balls can be determined. Both rings are then conveyed to the assembly position where the selected group of balls is inserted. The net result gives the desired fit within the specified tolerance range.

It is feasible for the product designer to incorporate a similar procedure into a product requiring a similar fit condition when manufacturing methods prohibit holding individual part tolerances to the degree required. The yoke and clevis assembly, Fig. 2, may possibly incorporate a simple spacer, which can be manufactured accurately to close tolerances and in a sufficient number of size groups to allow a wide manufacturing tolerance on the yoke and clevis and still result in a correctly fitted assembly.

Part orientation is of major concern in any automatic operation. Various operations require orientation from general location to very accurate positioning within a few ten thousandths of an inch. In an effort to reduce manufacturing costs, the product designer does not attempt to place tolerances on surfaces other than those requiring close fits at assembly. Generally, it is not possible to locate from and assemble to the same surface. A difficult problem can be made simple by providing such locating surfaces as a notch, protrusion, locating holes, machine surfaces, tabs, or ears. The drawing in Fig. 3 is typical of this problem. The flat wafer requires precise alignment for assembly of pivot shafts. The location was obtained by adding the protrusion in the wafer and holding the outside diameter to a closer tolerance as shown in the figure. The protrusion also provides orientation for the determination of correct face up.

One of the requisites of an automatic-assembly machine is to determine part presence at each working station. This prevents the machine from attempting to assemble additional parts into an empty station. Several methods are used. One is the photoelectric cell which lends itself particularly to small lightweight parts.

Parts with sharp edges and burrs are a hazard to mechanical feeding and conveying. They can cause major down-time problems in clearing jams and removing stuck parts. Chamfering of holes that take pins, rivets, or shafts is extremely helpful in preventing this. It also reduces the accuracy required for part positioning.

To reduce part-handling problems further it is possible to manufacture such simple parts as shims, washers, springs, and gaskets in the assembly machine. Springs are especially suitable for this approach as they are extremely difficult to handle and feed automatically.

A machine for assembling automotive-distributor-diaphragm linkages (figure at start of article) incorporates two die stations where the diaphragms are punched out from strip stock in the machine and immediately assembled to the linkage without additional handling. Simplifying the design of parts of this nature will definitely aid in making this approach applicable.

Fastening Parts

Methods of fastening parts after they are assembled are of extreme importance in determining the feasibility of automatic assembly. Riveting and staking are particularly suitable as they generally do not require additional parts such as screws, nuts, and snap rings, and the devices used for staking and riveting are simple and easy to maintain. Parts assembled with screws are suitable for automatic-assembly operations but require rather intricate equipment for feeding and driving. Snap rings and retaining rings are also suitable, provided some thought has been given to design. Retaining rings have an affinity for tangling, making feeding difficult, although this hazard may be reduced considerably by making a lap closure of tapered or stepped design.

Automatic feeding often mars external surfaces. Painted parts are particularly subject to this problem which is caused by the tumbling, abrading, or vibrating action of part feeders. If the painting operation cannot be performed after assembly, consideration should be given to some other type of surface finish which would be more durable. If the surface finish still remains a problem, magazine-feeding or operator-feeding methods should be used.

Conclusions

With automatic-assembly equipment, 100 per cent of the production passes through the machine. Thus each time the machine stops, production stops, and everything possible should be done to prevent machine down time. Any improvements in the product that will tend to make it more acceptable for automatic assembly should also be carefully considered.

Although only a few of the design problems have been discussed, the development of an automatic machine requires the combined skills and services of the production engineer, machine builder, gage engineer, quality-control analyst, and automation engineer. The product designer must now be added to this list if automatic assembly is to keep pace with improved technological advances.

How will the parts for your machine be made? As a designer, you need to be up on the facts of welding. Here is a comprehensive report.

WELDING PROCESSES

By John J. Chyle[1]

A. O. Smith Corporation,
Milwaukee, Wis.

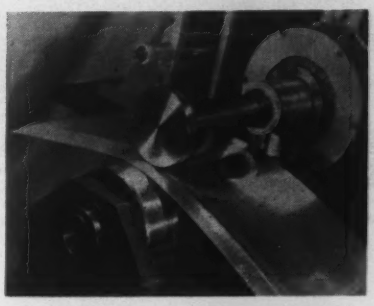

Fig. 1 Ultrasonic welding equipment developed for continuous-seam welding of thin foil as well as light sheet metal. A transducer and a coupling system are incorporated to a vibratory element and the ultrasonic energy is delivered continuously through the disk tip as the work travels between the active disk and the base roller.

THE need for new welding processes and further development in this field may be questioned by those who are unfamiliar with welding, but the answer is simple. As new metals and alloys are developed—such as columbium, vanadium, zirconium, hafnium, and tantalum—the problems of fabricating them by welding must be resolved. As the electrical engineer develops new electrical circuits, the welding engineer must utilize and incorporate them as power sources. When the mechanical engineer masters a new problem in stress design, the welding engineer must apply these principles. The ever-present search for lower costs without sacrificing quality is also a most important factor.

Considering only the field of fabrication by welding, there are three broad groups of welding processes—pressure welding, fusion welding, brazing—all of which have been known for a long time. The newer welding processes are, in essence, refinements of these basic processes.

Pressure Welding

The term pressure welding is applied to a group of related processes where force is of primary importance in obtaining the coalescence of metal either with or without the application of heat.

Ultrasonic Welding. Both spot and seam welding of metal can be accomplished with ultrasonic welding, which uses elastic vibratory energy in the joining of metals. A solid-metal conical "horn" serves as a mechanical step-up transformer to amplify small vibrations and to transfer them through a coupling system to a vibratory element which is in contact with the metal to be welded. The contact is at a very light pressure, only 25 psi.

A continuous-seam welder, Fig. 1, applies ultrasonic energy continuously to produce a pressuretight welded seam in either thin foil or light sheet metal. Metals difficult to weld by conventional methods—such as stainless steel, molybdenum, zirconium and its alloys, Inconel, tantalum, and titanium—can often be joined with this process. Ultrasonic welding is also used for the joining of not only similar but also various types of dissimilar bimetal combinations such as copper to aluminum.

Full thicknesses can be joined, but at present there is some limitation as the gage or thickness of the sheets is increased. Recent tests have been made in sheet-metal thicknesses of 0.090 in., and spot strengths substantially exceed the Military Specification requirements.

High-Frequency Resistance Welding. One of the newer resistance-welding processes, developed about 1950, depends on bringing high-frequency electrical energy directly into the object to obtain the desired heating characteristics. Alternating current of 450,000 cps is connected directly to the work by means of contact electrodes placed on each side of two abutting surfaces of metal. The edges touch at one end and the rest of the joint is open slightly, forming a sharp V. The current flowing from one contact hugs the surface of the other edge of the V as far as the root, and completes the circuit by returning along the opposite edge of the V with the second contact.

This skin effect produces localized high-intensity heating, so that the edges at the root of the V reach welding temperatures at the same rate as the strip progresses through the welding machine. Pressure applied at the root of the V brings the two edges together in a forge weld. The high-frequency welding process is applied to a 6-in. aluminum tubing, Fig. 2. Travel speed of the pipe can be as much as 200 fpm.

The process is applicable to a wide variety of metals

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[1] Director of welding research.

Contributed by the Machine Design Division for presentation at the Design Engineering Conference, New York, N. Y., May 23–26, 1960, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from Paper No. 60—MD-3 entitled "New Welding Processes."

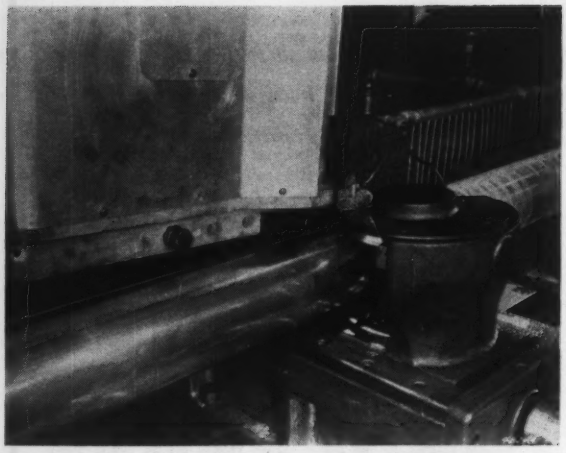

Fig. 2 Fabrication of 6-in-diam aluminum tubing with the high-frequency resistance-welding process. Alternating current generated up to 450,000 cps is connected directly to the work, which is to be heated by means of contact electrodes placed on each side of the abutting metal. The edges touch at one end and the rest of the joint is open slightly to form a sharp V. The current flowing from one contact hugs the surface of the other edge of the V as far as the root, and completes the circuit by returning along the opposite edge of the V with the second contact. Travel speed of the pipe can be up to 200 fpm. (Photograph courtesy of New Rochelle Tool Corporation.)

and alloys, including some of the highly reactive ones when inert gas is used for shielding, and such dissimilar metals as copper and aluminum have been welded.

High speeds can be obtained—up to 1000 fpm in light-gage metals of 0.012-in. thickness. The process is not limited to tubing, but can be applied to other shapes such as strips, T sections, and so forth. Spiral strips of metal can also be welded to the surface of the tubes. A significant advantage is the narrow heat-affected zone obtained, because of the relatively narrow band of heating which also accounts for the greater efficiency of the electric power used. The narrow weld zone may result in high tensile strengths and ductility.

Foil Seam Welding. Foil seam welding was developed in Germany and has found application where high speed—3 to 24 fpm on 0.087-in. stock—and freedom from distortion are important, Fig. 3. The flat joints produced require little, if any, final dressing of the weld metal. Butt-type joints can be made in flat strips or sheets, using a foil on either the top or bottom or both surfaces over the butt joint. The thin foil strips, which are from $^5/_{32}$ to $^3/_{16}$ in. wide and 0.007 to 0.010 in. in thickness, are used directly over the square abutting edges.

A small nugget is formed which increases gradually in width. The thin foil strip is pressure welded into the fused area. The principles of foil seam welding are basically the same as for conventional seam welding except for modifications for foil addition. This process has future potentialities because of lower finishing costs and dimensional uniformity.

Magnetic-Force Welding. Accurate synchronization of the electrode force and the welding current is achieved in magnetic-force welding by coupling the force or pressure with the magnetic force created by the welding current. This solves many of the difficult welding problems found where the electrode force is inherently synchronized with the current magnitude and duration.

The process can be used for the welding of high-conductivity metals to each other, and also to carbon steels.

The magnetic-force welder is generally of conventional design and is that of a direct-acting piston or ram-type spotwelder which has been redesigned to accommodate electromagnets for the application of pressure. The air cylinder actuates a ram for positioning the weldment between the electrodes, and also imposes a slight or initial pressure on the work prior to welding. Some combinations of materials need a longer heating period before welding. In such cases, as the welding current begins to flow, magnetic force is delayed to actuate the forging blow.

In most applications the welding time is of short duration, varying from $^1/_2$ cycle to a few cycles.

Percussion Welding. Percussion welding can be produced either by a rapid discharge of electrical energy from a stored-energy type of power source, or by the rapid dissipation of current with a standard 60-cps a-c source. The part to be welded has a small pinpoint type of projection formed or coined into the part, which is instantaneously vaporized upon contact during the downward movement of the electrode. In the stored-energy type of equipment, an air cylinder controls the rapid movement of the electrodes. In the resistance spotwelder, the magnetic force created by the welding current is used for the rapid movement of the electrode, and the welding time is usually $^1/_2$ cycle in duration.

One of the advantages of this process is the welding of large contact areas with the smaller capacity machines, and the high quality of weld that is produced. This welding process may have wide applications in the fabrication of ferrous as well as nonferrous metals, particularly for attaching small parts to very thin sections.

Friction Welding. Friction welding is a new process, described in Russian literature, which uses the heat produced by the friction of rapidly moving parts. Chucks hold the parts in line with the horizontal axis, one part rotating while the other is held stationary. Pressure is applied to generate sufficient heat for fusion of the parts to take place.

After the temperature is reached, rotation is stopped with the pressure being maintained, or sometimes increased, until the completion of welding, after which the weld is cooled in air. Total time for some of these parts may be from 5 to 25 sec, and the energy that is consumed may be only 10 per cent of that required for a similar weld fabricated by flash welding. Metal is plastically deformed and forms a reinforcement as a collar or bead.

A variety of materials—such as low-carbon, medium-carbon, free-machining and stainless steels, cast iron, brass, aluminum, and titanium, in addition to dissimilar metals such as brass to steel, brass to cast iron, and cast

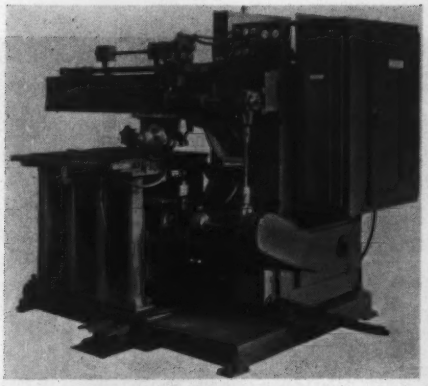

Fig. 3 Equipment for foil seam resistance welding. Basically the same principles are employed for foil seam welding as for conventional seam welding, except for modification for foil addition. (Photograph courtesy of Precision Welder and Flexopress Corp.)

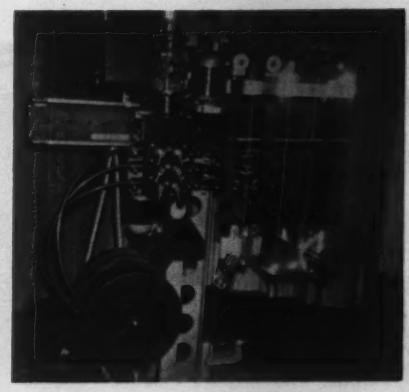

Fig. 4 Commercial equipment for electroslag welding, available in the United States. Called the Vertomatic welding process, it is suitable for making butt welds in heavy sections, using three electrode wires.

iron to copper have been welded. At present the process is limited to parts that are cylindrical in shape and that can be rotated.

Power requirements are low in cost and the speed of operation is high. The process has interesting possibilities for special applications to production welding of simple sections, because of lower initial costs.

Thermo-Pressure Welding. Thermo-pressure welding is in the field of solid-phase welding where the parts to be welded are under continuous pressure and the metal is heated until complete or partial plastic flow is obtained. The success of this process depends upon the cleanliness of the surfaces held under pressure and the application of heat to produce a true pressure weld. With thermo-pressure welding it is possible to weld metals to semiconductors and other metals which would be difficult to weld by the fusion welding process. Pressure may range from 5000 to 10,000 psi, and the temperature of heating may range from 200 to 300 C. The duration of pressure is important, and may vary from 5 sec to 10 min. The process may solve many of the problems related to making contacts to small areas without using chemical fluxes and melting in the fabrication of transistors and other semiconductor devices.

Diffusion-Bond Welding. Diffusion-bond welding may be defined as a pressure-welding process in which the metals to be joined are heated to a temperature below their solidus, and are held under pressure for some length of time. No liquid phase is formed and the bonding occurs by movement of atoms or intermetallic compounds across the interface on the surfaces, where intimate contact occurs.

For some diffusion-bond welding operations it is necessary to plate different metals on the parts to be joined. Sometimes combinations of two or three metals are plated, so that there is a barrier metal to prevent diffusion within the plated areas. In joining beryllium-copper to Monel, the beryllium-copper is first plated with nickel, then with gold. The Monel is plated with copper. The two parts are then diffusion bonded with pressure at 650 F.

The width of the diffusion zone is dependent upon the time-temperature factors, and as the temperature is lowered the time is increased to obtain the same diffusion width.

Only a few metal combinations have been used, such as the joining of beryllium-copper alloys to Monel and other metals. However, the process appears promising for joining many dissimilar metals and alloys.

After the plating operation, the parts are joined by applying pressures of 4000 to 8000 psi and temperatures generally below 1000 F. The duration of application depends on the metals to be joined and may extend from 20 min to 3 hr. During the bonding it may be necessary to use inert gas to prevent oxidation of the bonding surfaces.

The interface surfaces must be clean and they must be carefully prepared to obtain a smooth uniform intimate contact.

Fusion-Welding Processes

The term fusion welding is applied to a group of related welding processes in which heat is of primary importance in obtaining the coalescence of metal. Electrical energy, a chemical reaction between aluminum metal and metal oxides, or the combustion of gases and solid fuels may be used. A few of the important processes developed in the past 10 years, which appear to have promise, follow.

Electroslag Welding. One of the most recent processes is electroslag welding, first reported in Russia and used primarily for welding heavy sections, with plates ranging in thickness from 2 to 12 in. or more. Most readily adapted for welding vertical butt joints in heavy weldments, Fig. 4, the process can also be used for welding girth seams in heavy-wall cylinders as well as for building up large surfaces with weld deposit.

Fusion of the electrode wire and the parent metal takes place in and under a molten slag covering the bath from which the weld is formed. An arc is initially established under the granular slag, which melts it and raises its temperature to a point where the arc action is terminated and the current is conducted through the molten slag. The resistance of the molten slag to the flow of current then creates the necessary heat to melt the wire. The weld metal is obtained from the melting of the electrode wire in the superheated slag, and is deposited in the molten puddle of metal directly below. The weld is larger and wider than the width of the original component plate edges.

For making vertical butt joints in heavy plates, a number of electrode wires can be used simultaneously.

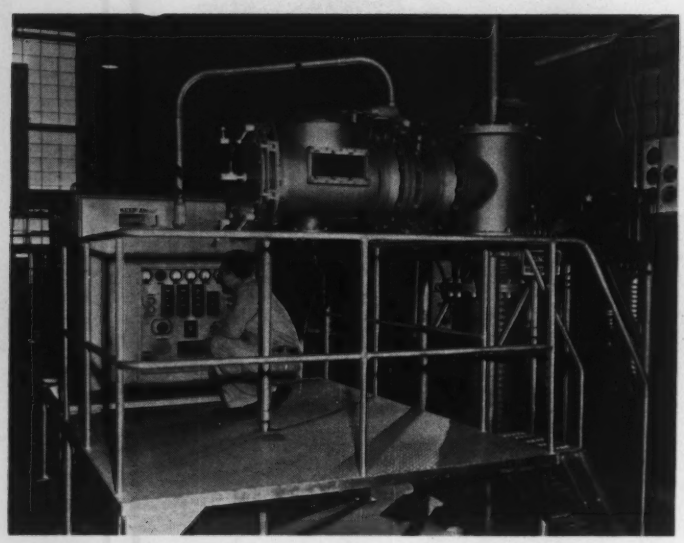

Fig. 5 Commercial electron-beam welding equipment. Electrons emitted from a tungsten-wire filament impinge upon the work piece in a high vacuum. They are given a high degree of acceleration and velocity by a high-voltage potential between the cathode and the anode. The workpiece is the anode and the electrons move from the cathode to the anode. (Photograph courtesy of Air Reduction Company.)

In some applications the wire can be oscillated back and forth so that the weld is uniformly deposited throughout the entire groove section. For making the vertical butt joints, the ends of the groove are enclosed by water-cooled copper plates so that the slag is confined in the weld area. These copper plates are moved upward as the deposition of weld metal progresses.

One of the advantages of this process is the high metal-deposition rate, which may be as high as 45 lb per hr of weld metal per single wire. Another advantage is the higher thermal efficiency that is obtained with this resistance-heating process, when compared to the true arc-welding efficiency of the submerged-arc welding process.

It is claimed that carbon steels, certain types of low-alloy high-strength steels, and stainless steels have been welded with this process in Russia.

One limitation is the large heat-affected zone adjoining the weld and the coarse columnar structure of the weld-metal deposit. Recommendations have been made to heat-treat the weldments by a normalizing type of post heat-treatment, to refine the grain structure. On large weldments, this would be a costly heat-treating operation, and problems of distortion would have to be considered.

Electron-Beam Welding. The principle of this relatively new process is based on the impingement of electrons on the workpiece in high vacuum. The electrons are emitted from a tungsten wire filament and are given a high degree of acceleration and velocity by a high-voltage potential between the cathode and the anode, and the electrons moving from the cathode to the anode. The workpiece is the anode.

Electron-beam welding equipment is being manufactured by a number of companies and test results have been reported by various laboratories, Fig. 5. The equipment consists of an electron-beam gun, a welding chamber, and vacuum-equipment controls. It is necessary to reduce the vacuum to a low value—approximately $^1/_{10}$ micron pressure.

Basically, the various electron-beam welders are similar in operation. The exception is in the focusing features which may vary, depending on whether the electron beam is directed by means of magnetic or electrostatic controls.

Because a high degree of vacuum is necessary to obtain electron bombardment, the operation is safe from contamination from atmospheric oxygen or nitrogen and from other foreign materials. Since operation from a purely electronic point of view is possible only below 2×10^{-4} mm Hg, the level of atmospheric impurities is less than 1 ppm. The best commercially available inert gases contain a level of 15 to 20 ppm of contaminating impurities. Such high purity is one of the distinctive advantages of the process.

The high temperatures which are developed vaporize some of the impurities in the parent material that is fused, with the resultant weld being much cleaner than the original base material.

Since the heating is being done by a beam of electrons originating at some distance from the weld, the source of possible contamination when the electrode or arc is in close proximity to the welding areas is removed, allowing the most reactive and refractory metals to be welded without contamination. The effects of welding temperature and the alloying effects of fusion welding can be studied for the first time without encountering contamination by gases or foreign materials.

An optical system for direct viewing, or an indirect optical system that can be focused to the work area can be incorporated.

Deep penetration is obtained and tests indicate that it is possible to obtain a depth-to-fusion-width ratio of 2 to 1, which implies a high temperature gradient.

Reports indicate that the quality of the welds is excellent, with freedom from porosity and slag inclusions.

Tungsten, molybdenum, beryllium, tantalum, zirconium, and hafnium have been welded satisfactorily. The process can be applied to some of the more common alloys such as stainless steel and carbon steels.

One disadvantage is the emission of penetrating short-wave radiation (x rays) when operating at very high voltages. This requires protection or shielding for personnel.

Arc Plasma. The arc-plasma type of heating produces ex-

tremely high temperatures ranging from 10,000 to 30,000 F. A gas—usually one of the inert gases, although nitrogen and hydrogen can also be used—is passed through a chamber in which an arc is maintained. The flow of electrons from the cathode to the anode ionizes the gas, and the resultant bombardment causes the gas to be heated to extremely high temperatures. The passages in the arc torch are constricted so that the water-cooled walls of the torch do not become hot. The ionized gases are forced through a nozzle so that the heated gases have the appearance of a flame emanating from the end of the chamber.

Plasma can be defined as any material that is heated to extremely high temperature and is largely in the ionized condition. It may consist of a hot stream of high-speed ions and electrons flowing at speeds from the subsonic to the ultrasonic ranges. The energy transmitted is largely due to the ionization of the atoms in the vapor and gases, and also to the dissociation of the molecules, which results in liberation of large amounts of thermal energy.

The electrode and nozzle of a plasma-flame torch are connected through electrical current connectors to a d-c type power source. Plasma-forming gas is fed into the nozzle inlet. An electric arc between the electrode and nozzle is struck by superimposing a high-frequency current. Gas flows around the electrode and through the umbrella arc, emerging as a plasma flame of 5000 to 30,000 F.

While the present application of the plasma torch is largely for spraying metals and refractory materials, the process has a vast potential for fusion welding of metals.

Brazing

Brazing is a term applied to a group of welding processes in which coalescence is produced by heating to suitable temperatures above 800 F, and by the use of filler metal having a melting point below that of the base metals. The filler metal is distributed between the closely fitted surfaces of the joint by capillary attraction. Flux may or may not be necessary, depending upon the method of heating and the metals to be joined.

Significant improvements have been made on a number of distinct welding processes in the brazing group, mainly in the brazing alloys and in the heating methods used.

One outstanding brazing achievement is the development of the sandwich-type and honeycomb-core constructions which are being widely used in aircraft construction and other applications. The component parts to be brazed are enclosed in a metal envelope hermetically sealed around the edges, and the entire assembly is placed in a furnace to heat to proper temperature.

Other modifications consist of heating the components in the sealed envelope to the required temperature, and then inserting the parts between two blocks. Sufficient pressure is exerted to hold and maintain the flatness and shape of the sandwich construction. Excessive pressure must be avoided to prevent buckling.

New methods of heating such as radiant heating, using high-intensity quartz lamps, have lately been investigated, and results have been satisfactory. Electric-blanket heating for brazing has also been developed as a commercial method.

With respect to brazing alloys, advances have been made in the use of the silver alloys containing small amounts of lithium for improved wetability.

Additions of inert ceramic materials such as Al_2O_3 in the brazing alloy have improved materially the uniformity of the fillets.

The future appears promising for brazing, and the applications for joining light-gage metals will increase, especially those metals that are difficult to weld by any other process.

Conclusions

Important developments in many of the established welding processes, such as the metal-arc coated-electrode process, will provide radical improvements in quality and performance of the covered electrodes. These will be in the low-hydrogen type of electrode, which will be nonhygroscopic and usable without the present precautions regarding storage.

Welding power sources will also be radically improved in the future as to their use in the various arc-welding processes.

Of particular interest is the development of the new square-wave a-c power source, which has found distinct applications in the welding of aluminum and other metals by the gas tungsten-arc welding process. Improved power sources for both a-c and d-c arc welding appear to be ready for commercial application in the near future.

Improvements have also been made in power sources for resistance welding, such as spot welding and seam welding, in which the control circuit has been modified so that it is self-correcting and adjusting. The energy for making the weld is controlled by an electrical computer system which determines the proper duration and current intensity for making welds. This automatic control for resistance welding is now commercially available.

New arc-welding processes have resulted in speeds ranging up to 400 ipm, and the guiding of the arc is becoming increasingly difficult. Several new principles for automatic guidance have been developed. New power sources and new concepts in welding are to be expected. The use of explosives for explosive welding has already been investigated, and preliminary trial has shown that it is possible to use the new heat source for fusion welding.

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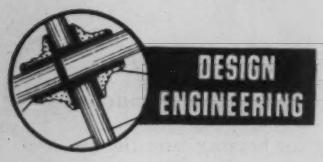

Now under development: Explosive forming. To the machine designer, this means a new method of fabricating machine parts. Tight tolerances can be achieved.

FABRICATION by EXPLOSIVES

By Vasil Philipchuk[1]

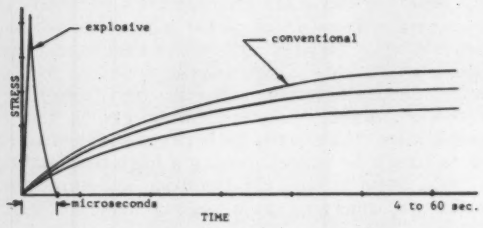

Fig. 1 Conventional versus explosive stress rate. It is in the high-rate stress-strain phenomenon that the plasticity of metals behaves differently under explosive forming. The metal moves rapidly through its elastic range into the plastic range, producing permanent set within microseconds.

THE field of metal-parts fabrication by explosives has been continually growing, although much of it remains in the research and developmental phase and is concerned primarily with the practicability of fabricating particular part designs of particular metals or alloys.

Explosive forming will serve as an adjunct to old and current fabricating techniques on a selective basis—both from the standpoint of economics and the ability to accomplish a fabricating operation. Higher quality, stricter tolerances, and quicker deliveries can be achieved in many applications.

Nearly all metal-fabricating processes require forces of varying degrees and application, and the extremely rapid chemical reaction represented by an explosive detonation can be utilized in certain metal-parts-fabrication processes. These explosive forces vary with the amount of explosive, the type of explosive, and the location of the pressure monitor from the explosive charge. If improperly combined, these forces will either have no effect on the metal, or shatter it. As in other fabricating techniques, metal temperature is important and is a factor in determining the proper process combinations, although practically all work to date has been conducted with the metal at ambient temperature.

The main avenues of interest in explosive fabrication are sizing, forming, forging, welding, compaction, and conditioning. Of lesser interest are embossing, shearing, flanging, joggling, threading, and extrusion.

General Formability

The difference between conventional and explosive fabrication is found in the pressure-time work curve of the two methods, which, essentially, shows a major difference in stress-strain applications [1].[2] In 1952, P. W. Bridgman reported: "High hydrostatic pressure on such metals as mild steel increased manyfold the plastic deformation possible before fracture" [2]. This statement has been found to apply to other metals and alloy systems when subjected to the proper combinations of explosive-force techniques.

The difference in the stress rates in conventional and explosive forming is shown in Fig. 1. In explosive forming, the metal moves rapidly through its elastic range and into the plastic range, producing permanent set or shape within microseconds. It is in this phenomenon of high-rate stress-strain that the plasticity of metals behaves differently from that observed under conventional stress-strain conditions where initial stress loads are much lower.

A complete understanding of the action taking place in the metal under high stress-strain rates is not known. The atoms in a metal crystal are spaced at intervals and held in position by the cohesive and repulsive forces acting between the atoms. In theory, it is these forces which are disturbed and rearranged under a stress which produces strain.

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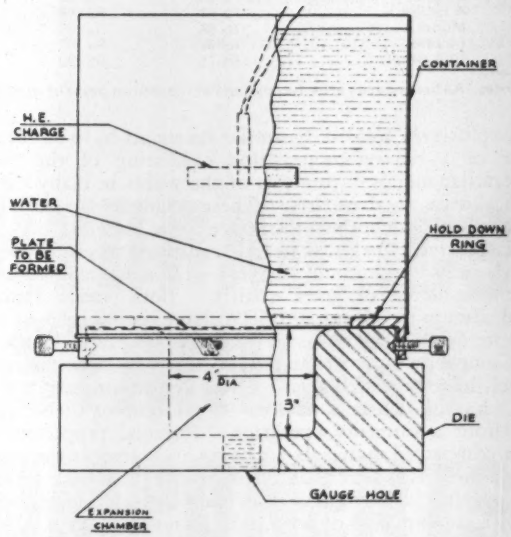

Fig. 2 The basic forming method : Immersing the explosive charge in water, with the water in contact with one side of the metal part. The pressure pulse forces the metal part into the shape of the female die.

Fig. 3 Metal parts explosively fabricated by various techniques. **Top row, left to right:** 1 to 3, stainless stress skin panels of 17-7 stainless, vascojet, and aluminum; 4, various configurations in one operation on 316 stainless steel; 5 to 10, basic forming of various metals. **Middle row, left to right:** 1, free forming and punch-out on 316 stainless steel; 2, free forming of annular shape on 316 stainless steel; 3 and 4, tube bonding of aluminum to steel; 5 to 8, aluminum forgings; 9 to 14, explosive welding specimens of various combinations. **Bottom row, left to right:** 1 and 2, embossing on aluminum sheet with plastic letters; 3 and 4, flanging of aluminum tubing; 5, jacketing of three steel tubes with copper.

The total deformation of a specimen is the integration of innumerable small displacements along innumerable slip planes. Slip interference, or "braking," takes place when the grain boundary is encountered. Then adjustment of the atoms, or "healing," takes place by the cohesive forces between the atoms.

It can be theorized that under high stress-strain rates associated with explosive forming, the atoms go through a series of slip, brake, and heal events very rapidly. The ultimate failure occurs when the healing process or cohesive forces between the atoms of the metal are insufficient to cope with the continued process of slipping. This occurs when the stress duration has been applied for too long a period. It is, therefore, necessary to control the duration of high stress application to prevent failure. There is a band of high stress-strain combinations which can be used for the successful forming of metals by explosive forces.

True explosive forming does not utilize the high range of explosive pressures on the metal part itself, but transfers this pressure through mediums which essentially dampen and distribute the forces to the metal. The metal forming takes place when these forces strike the metal with sufficient energy to move it through the elastic and into the plastic range of the metal or alloy. Generally, one should envision a pressure pulse striking a metal part with sufficient force to deform it and yet with insufficient force to fracture it.

Metals that fracture readily in an explosive-filled shell can readily be deformed into another shape without fracturing when the proper conditions and technique of applying explosive forces are used. Parts ranging from extremely thin sheet (0.008 in. thick) to heavy-walled fabrications (4.0 in. thick) have been explosively formed.

Methods

Although the methods used for the various fabrication processes vary, in general, the principal method consists of immersing the designed explosive charge into water, with the water being in contact with one side of the metal part, Fig. 2. A female die having the desired finished contour is behind the metal part. Depending upon the starting and final shapes, the necessity for a vacuum between the die and the part is determined. The explosive charge is detonated, transmits the pressure pulse to the metal part, and forces it into the shape of the female die. The variations in this method are found in the die material, the medium for force transmittal, and the general setup.

The methods for forging, welding, compaction, and conditioning require preparation of the metal and die surfaces prior to the operation. Each of these operations requires higher pressure forces than those needed for the forming of sheet material. Most of the operations are such that the fabricating process can be set up indoors. Where great quantities of explosive are used, the setup is made outdoors to prevent damage from residual or reflected shock or blast fronts.

Materials

Nearly the entire span of readily available metals and alloys has been under test, particularly those for high temperature, and exploratory tests have been made with

rare or expensive metals and alloys. Sheet, plate, cylinders, cones, powders, and pellets have been among the one or more starting forms. Weights of formed parts have ranged from a few grams to over two tons with the upper limits determined principally by the ability of the facility to handle the metal part and die and to withstand the noise of the explosive charge.

Basic study by the author's company of the behavior of plastic flow under the high stress rates produced by explosive forces has been aimed at obtaining a relationship between the known conventional plasticity of the metal and that possible under high stress rates. Evaluation of the data indicates that the ability of a metal to be formed by explosives is a direct function of a mechanical property—per cent elongation. Other parameters enter into the relationship which can be stated as:

$$P_e = K_m f \text{ (per cent elongation, temperature, medium, explosive)}$$

where

P_e = the maximum amount of plasticity (without fracture) available through explosive forces

K_m = a constant, determined by experiment, for a particular family of metals, such as aluminum, stainless steel, or titanium.

The per cent elongation used is that established by the metal fabricators. The temperature is that of the metal when subjected to explosive forces. The medium used for force transmittal (air, water, or other) affects the energy transmission. The type of explosive used is a function of plasticity since different explosives have different pressure-time pulses which affect the stress-rate application.

A metal constant, K_m, greater than 1.0 will indicate that explosive forming has occurred to a degree much greater than the conventional per cent elongation. The constants obtained thus far for various groups of metals and their alloys under convenient test conditions (with water as the medium, using explosive A, and at ambient temperature) are: Nickel, 1.0; stainless steel, 1.1; titanium, 1.5; plain carbon steels, 2.3; aluminum, 2.5. The indicated K_m for tool steels and magnesium are both greater than 2.0, although the determination of data for these and other metals are still in the test stages.

The task of obtaining complete data with all parameters investigated on all of the metals is monumental. The function of medium, temperature, and explosive must be determined for each family of metals in order to obtain maximum plasticity with explosive stress. The data are vitally needed to provide the best possible and widest choice of materials for the design of supersonic aircraft and missiles.

Material Properties

The material properties obtained from explosive forming closely match those from cold working and the process is essentially a cold-working operation. Laboratory tests of specimens which had been mechanically cold worked had identical physical properties to specimens that had been explosively formed to the same degree. Both hardness and ultimate strengths increase with explosive forming, Table 1.

Table 1 Typical Explosive-Formed Physical Properties, Metal Stretched 30–35 Per Cent

	Hardness before forming	Hardness after forming
Inconel X	R_c 18	R_c 30
A nickel	R_b 62	R_b 99
Monel	R_b 68	R_b 95
Inconel	R_b 80	R_b 102
1020 Steel	R_b 72	R_b 100

Note: All hardnesses after forming are at maximum point of working

Explosively welded dissimilar materials have an interface of a binary composition consisting of the two dissimilar metals. Analysis of the welds in many cases has shown good quality. These welds are essentially fusion welds of surface-to-surface sheet material.

Explosively forged materials exhibited physical properties above minimum conventional requirements and are considered of good quality. Both steels (1020) and aluminum alloys (7075-T6) have been forged to accurate dimensions on parts that have no radical draft.

Compacted-powder materials, such as titanium and steel, have produced small pellets (approximately 1 × 1 in.) having densities of over 95 per cent of theoretical without a sintering operation. Physical properties of the compacted materials are being evaluated at the present time. It is here that a new branch of powder metallurgy, that is, high pressure in place of high temperature, and a combination of both, will be under study. Much study of mechanical high pressure is already being pursued by P. W. Bridgman, who has attained ultrahigh pressures of 50,000 atm. H. Tracy Hall has reported these and other studies of very high mechanical pressures on the effect of crystalline structures [3]. Small compactions by double-acting explosive presses on titanium powder achieved 95 per cent of theoretical density. This work was sponsored by the Navy and reported by E. W. LaRocca and John Pearson [4].

The parts that have been made are usually those requiring specific tight tolerances which can be achieved in explosive fabrication. Some examples are shown in Fig. 3. These have included stainless motor housings (10 to 43 in. in diam), mild-steel fan housings, the hardening of railroad frogs, rocket nozzles from a variety of metals, missile nose cones and domes, and various aircraft parts. Tolerances as close as 0.001 in. have been achieved on specific parts. Die defects are impressed on the part when close tolerances are in effect. Most sheet parts tested require a ±0.005-in. tolerance. This can be achieved providing there are no sharp radii or extreme breaks in the final design.

Discussions between the design engineer and the fabricating engineer are highly desirable, since, in many cases, a compromise can be reached for successful fabrication. Savings on over-all costs can be attained by the proper design-fabricating-tooling combinations just as metal parts are formed successfully by the proper explosive-technique-tooling combination.

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For you, the machine designer, hydraulics becomes an application of standard, proved components, a building-block procedure. Coming: Fluids that are fire-resistant. The trend: Electrohydraulics, combining the brain of electronics with the brawn of hydraulics

HYDRAULICS: STANDARD COMPONENTS

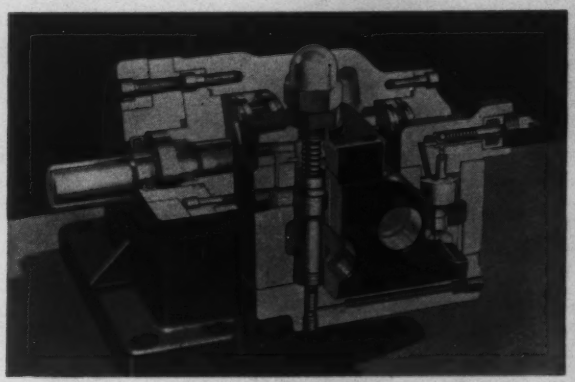

Fig. 1 A combination double-vane pump, made in two basic series, and with interchangeable pumping cartridges which make possible a wide variety of standard flow combinations

By E. I. Brown[1]

When a machine designer or builder starts to adapt hydraulic power to his machine and select the hydraulic gear to do the job, he has six principal things in mind: performance, reliability, initial cost, availability schedules, serviceability and maintenance, and noise.

Standard components can be manufactured and sold at favorable cost, and delivery is, of course, better than would be expected for a special assembly. The reliability and serviceability of the component will have been proved by prior field service in similar applications, or the standard product would not have become popular. The criterion seems to be: "Never design a special piece of hydraulic gear unless a standard piece of gear cannot be found to do the job." The principal trend, then, in industrial hydraulics is toward the selection and use of standard components which can be connected together to form the system.

Pressures

Pressures used in industrial hydraulics commonly fall within distinct ranges which seem directly related to the types of machines. Metal-forming machines, such as presses, normally use pressures up to 3000 psi, sometimes as high as 5000 psi, but this is not yet common. Metal-cutting machines use pressures in either the 300 to 1000-psi or the 1000 to 2000-psi ranges depending upon the size of the machine. Intermediate pressures (1000 to 2000 psi) are common in plastic molding machines because of a combination of the above reasons for low and high pressures.

The 300 to 1000-psi range is popular on metal-cutting machines because, in this type of machine, there is invariably a feed rate which must be accurately maintained. Low pressures mean relatively large actuators which, in turn, mean larger volumes passed by the metering device. In general, the greater the flow rate the more accurately the rate may be controlled. This pressure range results in less tool-jump with change in load, because of the compressibility factor.

Another factor affecting choice of relatively low pressure for this type of machine is the great importance put on reliability and long life of the equipment. Machines of this type are likely to be part of an automated line wherein down time may be calculated to be as high as $5000 per min.

Higher pressures are common in the press field in order to reduce size of the rams. A recent survey of press builders indicates that about 4000 psi might be the optimum pressure for heavy presses; however, the great majority of builders are willing to compromise on the 3000-psi range because of availability of standard, proved equipment for this pressure range.

The Building-Block Approach

Fig. 1 shows a combination double-vane pump. By interchanging pumping cartridges in two basic series of

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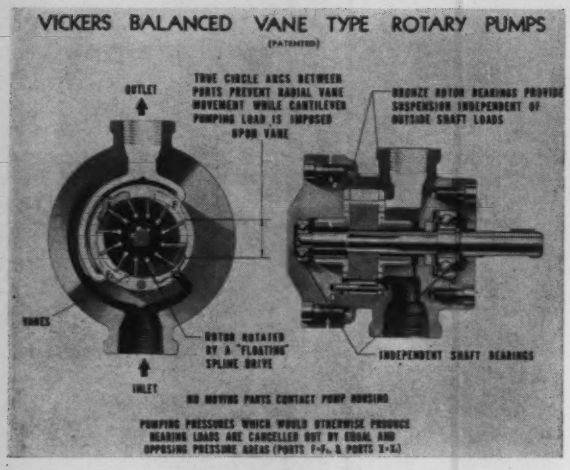
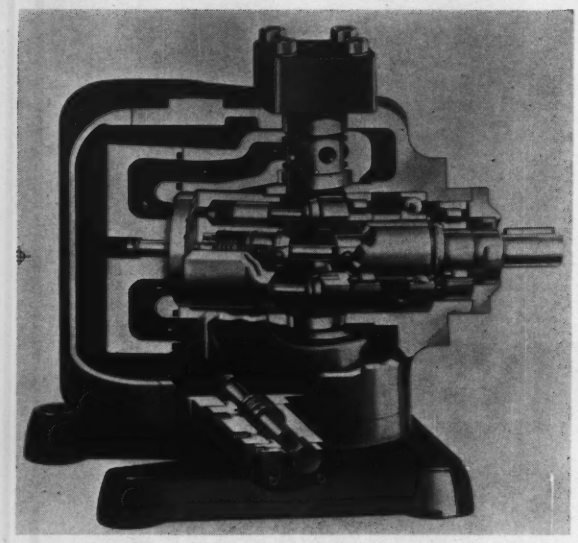

VICKERS BALANCED VANE TYPE ROTARY PUMPS
(PATENTED)
OUTLET
TRUE CIRCLE ARCS BETWEEN PORTS PREVENT RADIAL VANE MOVEMENT WHILE CANTILEVER PUMPING LOAD IS IMPOSED UPON VANE
BRONZE ROTOR BEARINGS PROVIDE SUSPENSION INDEPENDENT OF OUTSIDE SHAFT LOADS
VANES
ROTOR ROTATED BY A "FLOATING" SPLINE DRIVE
INDEPENDENT SHAFT BEARINGS
INLET
NO MOVING PARTS CONTACT PUMP HOUSING
PUMPING PRESSURES WHICH WOULD OTHERWISE PRODUCE BEARING LOADS ARE CANCELLED OUT BY EQUAL AND OPPOSING PRESSURE AREAS (PORTS 1-4, & PORTS 2-3)



▲**Fig. 3** Cross section of an axial, angle-type, variable-displacement piston pump. Rods and pistons are attached by sockets to the drive-shaft flange. To vary the output, you vary the angle of the cylinder block.

◀**Fig. 2** A typical fixed-displacement vane pump. The diametrically opposed intake and exhaust ports equalize the radial loads.

pumps, a wide variety of standard flow combinations is possible. Note the two adjustments. The one on the right is the relief valve adjustment which determines max operating pressure. The other is the unloading valve adjustment which determines the pressure at which one of the pumps unloads freely back to tank.

Since the cost of the average piston pump is many times the cost of the average vane pump, it follows that there are more vane pumps in use than piston pumps.

Vane pumps have predominated in machine-tool applications for the following reasons:

1 They retain satisfactory efficiency over a much longer service life.

2 They are higher in efficiency and therefore generate less heat over the life of the pump.

3 They are quieter and therefore can be used in machine shops without undue irritation to the operating personnel.

4 They usually have a replaceable cartridge, thereby facilitating quick and easy service and eliminating the need of disturbing the piping.

Fig. 2 shows a typical fixed-displacement vane pump. Pumps of this type have been in common use for the past 30 years and have an excellent service record. Note that it has diametrically opposed intake and exhaust ports which equalize radial loads imposed by pressure. Wear is automatically compensated for by this feature and the fact that valving surfaces are held in contact with the rotor by pressure. It also has a hydraulically balanced rotor resulting in minimum load on the bearings and therefore smaller size and lower costs.

Two-stage pumps have been commonly used for the intermediate pressures up to 2000 psi. A recent development is the high-performance, single-stage, vane pump rated at pressures up to 2000 psi and speeds up to 2000 rpm.

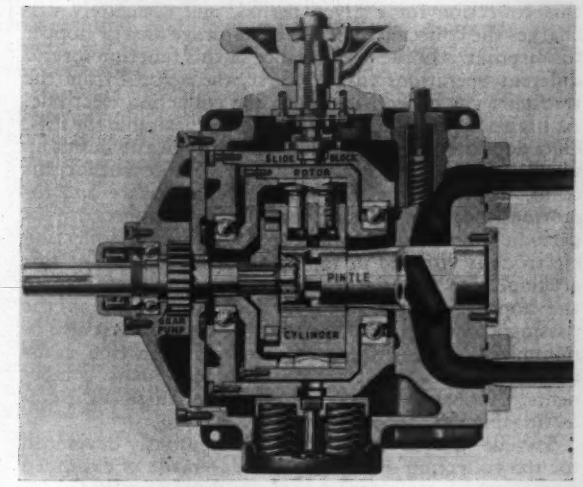
The Piston Pump

The piston pumps used in the industrial field are of the same basic configuration as the aero type, although they are not of the lightweight design and are much larger. These h-p pumps are made in both the fixed-displacement and variable-displacement types with a number of methods of control available on the latter. A great range of sizes (from 3 to 500 gpm) is also available so that the machine designer has a number of standard, proved pumps from which he may select the one which best fits his application.

Fig. 3 illustrates a cross section of a Vickers axial, angle-type, variable-displacement piston pump. In this type, the rods and pistons are attached by means of sockets to the drive-shaft flange. Variable output is obtained by varying the angle of the cylinder block with respect to the drive shaft. Maximum displacement is obtained at the maximum angle of 30 deg. As a rule, nine pistons are used, but some units have seven or eleven pistons. The units are made in sizes with input horsepower varying from about 5 hp at 1200 rpm to approximately 650 hp at 650 rpm. Units are designed for maximum pressures ranging from 2000 to 5000 psi and are characterized by high efficiencies at all stroke angles relative to other piston pump types. Over-all efficiencies of 92 per cent and volumetric efficiencies of 97 to 98 per cent are not uncommon.

Another type of variable displacement piston pump employs a swash plate to control displacement. This type, made by both Denison and Vickers, generally has been designed for pressures from 3000 to 5000 psi. Hydraulic motors of both the angle and swash-plate types in most cases are identical to the pumps. Swash-plate units are made in sizes from approximately 10 hp to 180 hp at their maximum pressures and speeds.

Fig. 4 illustrates a radial piston pump manufactured by the Oilgear Company, which is the third major type



▲**Fig. 4** A radial piston pump, with beveled reaction rings which impart a rolling motion to the radially disposed pistons

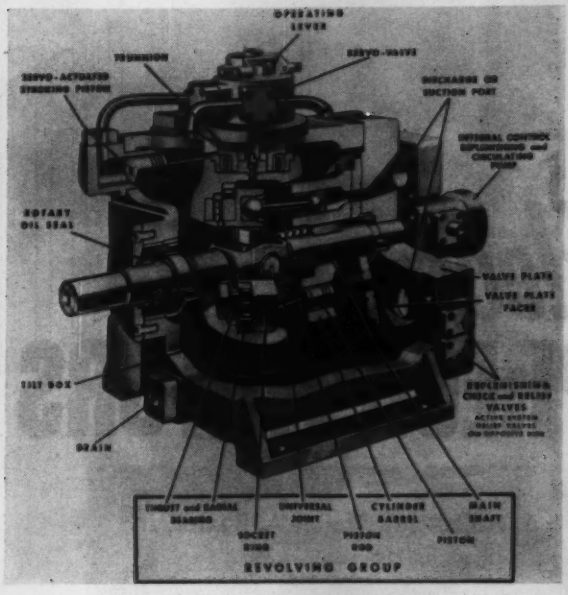


Fig. 5 One of the earliest of all h-p piston pumps, incorporating the same piston-retraction principle as in later angle designs. The load is carried through a universal joint. ▶

of piston pump used industrially in America. This type of unit employs beveled reaction rings which serve to impart a rolling motion to the radially disposed pistons. In this design, rotation of the pump unit is obtained by a shaft which is coupled directly to the cylinder barrel, which in turn is mounted on a fixed pintle through a splined floating coupling. Oil gear units are made in sizes from about $2^1/_2$ hp to somewhat over 150 hp with max pressures in the 3000-psi range.

One of the earliest of all h-p piston pumps is the unit shown in Fig. 5 made by the Waterbury Plant of Vickers Incorporated. These units, designed around the turn of the century, were originally called the Williams-Janney pumps.

They incorporated the same piston-retraction principle as used in later angle designs. The Waterbury unit is similar to the Vickers axial-piston unit shown earlier, with the exception that all of the load is carried through a universal joint. It has been made in sizes from about 10 hp to 3600 hp at 400 rpm. It is particularly suitable for heavy machinery drives and has been applied to winches, tube reducing mills, presses, ship steering gear, radar drives, etc. It is a smooth operating unit and has excellent efficiency. Variation in displacement is obtained by changing the angle of the tilt box.

Rotary Motors

Rotary motors are also of the same three basic types, namely, gear, vane, and piston. Vane motors are replacing gear motors for many of the l-p applications. Piston motors are used for h-p applications and also for some l-p applications when precise control is important. Piston motors also can be of the variable-displacement type.

With input flow and pressure remaining constant, the displacement of this type of motor may be varied to obtain constant-horsepower characteristics at the output shaft over approximately a 4:1 speed range. The same variety of controls are available for these motors as are available for the variable-displacement piston pumps.

Looking Ahead

There is already a growing trend toward the use of fire-resistant fluids in hazardous applications. This trend will receive increasing emphasis with the use of lower-cost fluids such as the water emulsion type.

There is no doubt but that machine tools will continue the trend toward automation and the use of electrohydraulic servo systems in order to reduce labor costs. The process industry is also moving in the direction of electrohydraulic systems in order to combine the brain of electronics and the muscle of hydraulics, and to obtain the high-speed response characteristics of this type of system.

Hydraulic variable-speed drives will gain with respect to electrical and mechanical variable speed drives because of better response and better control characteristics. Hydraulic power transmissions will be used in machine applications that have used only mechanical power to date in order to achieve precise and variable control. Spindle drives and such fall in this category. A greater degree of standardization will be achieved in order to reduce cost and provide reliability and serviceability.

In the mobile field, hydrostatic transmissions will be developed and used on off-the-road machinery because of higher efficiency and better control than hydrokinetic transmissions. Mobile auxiliary system pressures may rise above the 2000-psi range and pump speeds should exceed the 4500-rpm range. Central hydraulic systems look promising for both off-the-road machinery (earth-moving, materials-handling, and farm machinery) and automotive equipment. Mobile equipment will become more sophisticated with controls such as electrohydraulic servo valves.

Electrostatic PRECIPITATORS

Harry J. White[1] and Walter A. Baxter, Jr.[2]
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An investigation to optimize the performance of the collecting plate. Recommended: The solid plate.

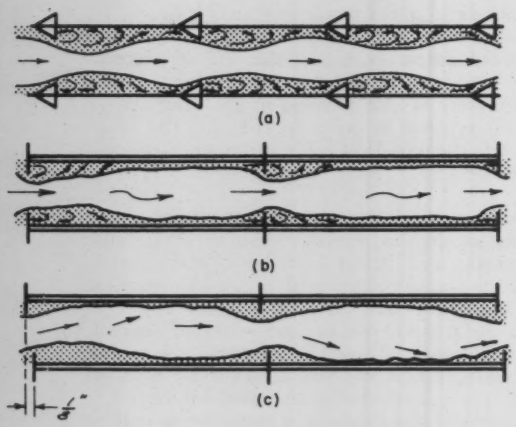

Fig. 1 Gas-flow patterns at velocities of 3 to 15 fps: **(a)** Solid plate, **(b)** expanded-metal plate, **(c)** expanded-metal plate (misaligned). Baffles provide a low-velocity contraflow at the plate surface, helpful in recapturing eroded particles.

An electrostatic precipitator electrically collects a dispersoid from its transport medium, retains this collection for a given period, and ultimately discharges the collected material to a storage area or hopper for disposal. In the performance of this function several different operations ensue. First, the aerosol from the transport gas is deposited onto the collecting electrode. As high a deposition rate as possible is desirable for this. Once deposited, the collected material typically builds up to a layer perhaps $^1/_4$ in. thick. It is important for this collected dust to be held on the plate surface and for erosion into the passing gas to be minimized. At periodic intervals, typically every $^1/_2$ min, the collecting electrode is vibrated or rapped to dislodge some of this accumulation and the discharge falls under gravity to the hopper. The amount of dust resuspended in the passing gas stream from these falling chunks must also be minimized. To perform this complex function satisfactorily, a precipitator necessarily has many components. Probably the most important of these is the collecting plate.

Two designs of collecting plates previously developed for the collection of dry dispersoids—made of expanded metal and of perforated metal—will be described. Intuition and experience have been the chief criteria for such design development in the past. A scientific investigation intended to optimize performance of the diverse functions of the collecting plate which demonstrated the superiority of a solid plate design will be reported.

Functions of the Collecting Electrode

The collecting plate acts as the target electrode for the corona discharge emanating from the high-tension wire. This function must be performed in various atmospheres and with the plate coated with materials of widely differing physical, chemical, and electrical characteristics. Since precipitator performance is intimately linked with voltage level, it is important that the plate be designed for the highest possible voltage.

The local electrical-field distribution at the collecting-plate surface is also important. Surface irregularities or sharp edges cause high local stresses which lower the sparking voltage and the over-all energization level.

The dispersoid to be collected may vary in electrical resistivity over a considerable range. If resistivity rises above about 2×10^{10} ohm-cm, collection becomes increasingly difficult because of the formation of back corona—a localized discharge which occurs from the collecting-electrode surface when that surface becomes coated with a layer of poorly conducting dust.[3]

Incipient back corona lowers the sparking voltage while severe back corona produces an opposite-polarity ion discharge at the collecting electrode which tends to neutralize the corona discharge from the wire. Under this latter condition, particle charge is greatly reduced and opposite-polarity and neutral particles may actually outnumber the normally charged particles.

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[1] Formerly, Director of Research and Development. Currently, Professor of Applied Science, Portland State College, Portland, Ore.

[2] Project Engineer, Research Section.

[3] H. J. White, "Characteristics and Fundamentals of the Back-Corona Discharge," Gas Discharge Conference, Brookhaven National Laboratory, Brookhaven, N. Y., October, 1948.

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Uniformly distributed flow of the dust-laden gas must be maintained down the channels between the collecting plates at the highest velocity possible concomitant with low erosion and re-entrainment loss. Correctly designed baffles are necessary to prevent re-entrainment of the collected dispersoid during rapping.

Plates are typically rapped in banks of about eight and the rapping blow, to be effective, must be transmitted to all areas of the plate with minimum attenuation. Stiff designs are preferable to spongy or nonelastic ones which increase the rapper power requirements and the number of rappers needed, and decrease the uniformity of vibration across the plate surface.

A satisfactory collecting plate must also meet several mechanical criteria. The plate must be quite rigid and resistant to permanent deformation and yet be light enough for easy handling. Modern high-volume precipitator design may call for plates up to 30 ft high. Internal temperatures may go as high as 750 F. One bowed or misaligned plate will reduce the voltage that can be applied to an entire precipitator section comprising perhaps 100 plates and thereby seriously impair precipitator performance.

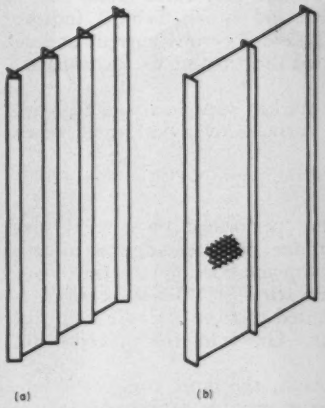


Fig. 2 The test plates used in making performance comparisons: (a) The solid plate, and (b) the expanded-metal plate. The expanded-metal plate was 56 per cent open.

Experimental Investigations

Electrical Performance of Surfaces. In order to get a clear, unbiased picture of the electrical performance of various collecting-electrode surfaces, these were studied uncomplicated by the merits or defects of the appurtenances (baffles, stiffeners, and so on) that make up the complete collecting plates. The form of these auxiliary components allows wide variation at the discretion of the designer.

Three surfaces, each 3 ft sq, were studied: (*a*) Solid sheet, (*b*) expanded metal (56 per cent open), (*c*) perforated metal (37 per cent open). The expanded-metal surface had diamond-shaped openings and the perforated surface had round holes, but were otherwise quite similar. Precautions were taken to prevent such extraneous influences as edge effects or surface irregularities from influencing the analysis. These plates were set up as a single duct at 8-in. plate-to-plate spacing with three 0.109-in-diam discharge wires spaced 6 in. apart between them.

The solid plate was able to maintain considerably higher voltages without sparkover than the partially open configurations, which may be ascribable to the localized high fields caused by the surface irregularities of the perforated surfaces.

High-current back corona was detected on all three surfaces. The resistivity required to produce back

Fig. 3 The solid plate after injection of 600 grams of 79 per cent —5-micron fly ash at 9 fps and 50 kvp half-wave

Table 1 Back Corona Comparison—Solid Versus Perforated Sheet

Dust	Temp, deg F	Sheet	Current at onset of back corona, amp	Ratio of currents in solid and perforated sheets at back corona point
Talc	200	Solid	2.0×10^{-4}	2.5
		Perforated	8.0×10^{-4}	
Talc	300	Solid	1.4×10^{-4}	2.8
		Perforated	5.0×10^{-4}	
Fly ash	200	Solid	1.9×10^{-4}	4.0
		Perforated	4.7×10^{-4}	
Fly ash	300	Solid	1.1×10^{-4}	9.1
		Perforated	1.2×10^{-4}	

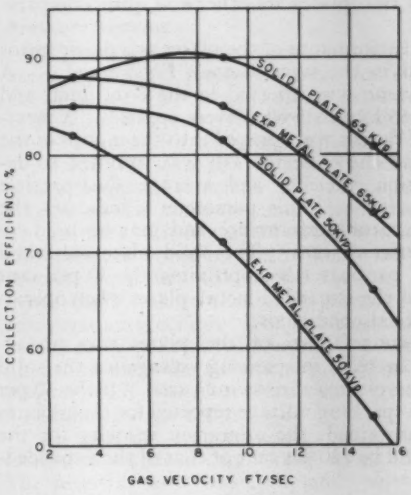


Fig. 4 The effect of gas velocity on collecting efficiency with 79 per cent —5-micron dust, and half-wave energization

corona in solid plates, however, was greater than 10^{11} ohm-cm as compared to values of the order of 1 to 2 × 10^{10} ohm-cm for expanded and perforated-metal sheets. The results of tests on talc and fly ash, Table 1, indicate that the solid sheet will take a corona current at least twice that of the perforated sheet before back corona sets in.

These tests indicate a marked superiority in electrical characteristics for solid surfaces over perforated or expanded sheets.

Aerodynamic Properties

Wind-tunnel tests were performed on several plate structures. The wind tunnel was rectangular in cross section with transparent top and bottom to permit visual and photographic observation. Full-size sections of various plates were mounted to form a single 8-in. duct 1 ft high and $4\frac{1}{2}$ ft long. Gas velocities ranged from 3 to 30 fps.

Regarding dust collection, the most significant function of the plate baffles is to provide a low-velocity contraflow at the plate surface which adds greatly to the likelihood of recapture of an eroded particle and also provides a shielded area through which the dust may fall into the hopper after the rapping blow. Figs. 1 (*a*) and (*b*) represent a plan view of the gas-flow patterns observed for the expanded-metal plate section and the best of the solid-plate configurations. Triangular baffles provided the most stable low-velocity area along the plate surface. In particular, flat projections, as shown in Fig. 1 (*b*), make poor baffles because small end misalignments ($\frac{1}{8}$ in.) cause the gas to snake through the precipitator, Fig. 1 (*c*), with resulting scouring of the plate surface and increased erosion losses.

Prototype Tests

Electrical. In view of the electrical superiority of the solid sheets and the aerodynamic superiority of the described baffles, prototype collecting plates were constructed for further study and comparison with expanded-metal plate designs, Fig. 2.

Full-size, single-duct electrical tests (4-in. wire-to-plate spacing) showed a sparkover voltage under clean conditions of 112 kv for the solid plate and 80 to 88 kv for the expanded metal. The current-voltage characteristics of the two plates are otherwise quite comparable.

Precipitation. Performance of the plates as a precipitator was determined in the wind tunnel, Figs. 3 and 4. A high-voltage frame was inserted in the 8-in. duct, and voltages up to 65 kvp half-wave were applied. A measured amount of fly ash was sprayed into the mouth of the wind tunnel and the collected ash was weighed to determine collection efficiency and average dust-particle migration velocity w. This parameter w indicates the level of precipitator performance and may be used to compare dissimilar designs. The solid plate exhibited a precipitation parameter w approximately 30 per cent higher than did the expanded-metal plates when operating under identical conditions.

These wind-tunnel tests of the plates take no advantage of the increase in sparking voltage for the solid plate which the electrical tests indicated. If the 30 per cent increase in sparking voltage reported for clean plates were to be maintained, the migration velocity for the solid plate would be 220 per cent of that of the expanded-metal plates.

Mechanical. Collecting plates must be strong enough to withstand the stresses of rough handling without becoming bowed or otherwise distorted. The measured sag of expanded-metal plates was found to be 17 per cent higher than the sag of solid plates at the baffles and 57 per cent higher at the plate center.

Under the usual conditions found in normal handling, the solid plate will not be subject to stresses in excess of the elastic limit of steel and the expanded-metal plate may suffer permanently deforming stresses. Full-size expanded-metal plates, complete with all appurtenances, were also found to be about 17 per cent heavier than the solid plates.

Rappability. As far as the plate is concerned, the criterion for good rappability is the smallness of the energy losses due to internal friction. The attenuation of the rapping blow was greater for the somewhat spongy expanded-metal plate than for the solid-sheet plate. This was measured by the ratio of the amplitude of vibration immediately after rapping to the amplitude after a given time interval.

First Cost. The prototype plates had an indicated first cost of about 67 per cent of that of the expanded-metal type.

Summary

The solid plate is superior in every laboratory measured characteristic to the expanded-metal plate, Table 2.

Table 2 Comparison Between Solid and Expanded-Metal Plate

Characteristics	Ratio $\frac{\text{solid}}{\text{expanded}}$
Clean-surface sparking voltage	1.3
Measured w at a given voltage[a]	1.3
Expected w at sparking voltage[a]	~2.2
Dust resistivity to cause back corona	~5
Baffle effectivness in providing a shielded flow area	~2
Susceptibility to gas snaking due to misalignment	~0.3
Measured sag at plate baffles	0.86
Sag at plate center	0.64
Maximum stress due to own weight	0.67
Weight	0.86
Rappability	>1
Expected first cost	~ .67

[a] w = dust particle theoretical migration velocity to collecting electrode.

Field Results. The new plates are being used on more than 50 precipitator installations to date, treating a total of over 25 million cfm of gas. Applications include fly ash from pulverized-coal-fired and cyclone-furnace power boilers; cement-kiln, gypsum, powdered-catalyst, and alumina dust; paper-mill, oxygen-converter, and open-hearth fume. At present approximately 50 per cent of these precipitators are in operation and test results are available on a total of 13 installations.

Every one of the 13 new plate precipitators tested has exceeded guarantee efficiency on first tests after being put in service, confirming the superiority of the new design indicated by laboratory tests. In addition, the superior mechanical strength and rigidity of the new plate over the expanded-metal design have allowed a change to substantially larger plates. This advantage is of importance in view of the restricted floor area available for many precipitator installations.

Acknowledgments. Acknowledgment is made to Dr. P. Cooperman and J. A. Armstrong for invaluable contributions to the work.

By designing ingenious equipment and using commercially available components, they built their laboratory for the testing of valves —and stayed within the budget

MORE LABORATORY FOR LESS MONEY

By C. A. Anderson,[1] Mem. ASME, and R. A. Gulick[2]

W-K-M Division of ACF Industries, Inc., Houston, Texas

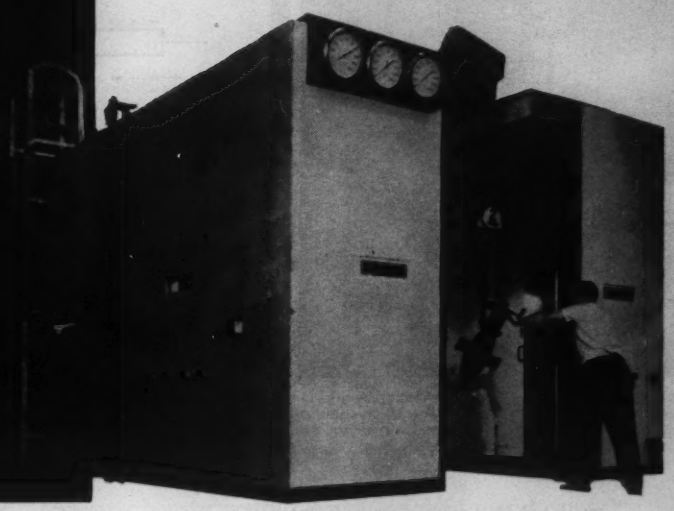


Fig. 1 The destruction cell has a door in the roof as well as vertical main doors, to allow crane entry. Walls and roof are of 8-in. doubly reinforced high-strength concrete with two bulletproof windows in each of two walls. Capped openings extend through the wall for carrying control extensions and electrical connections out of the test cell.

In 1956, the Engineering Department had outgrown its testing laboratory in the W-K-M Plant at Missouri City, Texas. Since the company's products consisted mainly of steel valves, semisteel valves, and return-bend fittings, a new physical-testing laboratory was patterned around the operating requirements of these products. A budgetary limitation of approximately $75,000 made it necessary to adapt and modify commercially available components. The way in which it was done may be of interest to other companies faced with similar problems.

The design criteria were made as general as possible to make the laboratory of use regardless of the type of testing needed. Destructive testing of pressure vessels was a primary requirement. The 100,000-psi pressures that would be used made a test cell necessary for containment and safe observation during actual destruction.

Stress-coat facilities were available as were the normally required measuring instruments and gaging equipment. It was highly desirable to have equipment for stress analysis which would sample the strains, perform the computations, and record the apparent stresses from a group of strain gages without resorting to manual recording and mathematical manipulations by the engineers.

Cyclic testing of valves as near to operating conditions as practical, was to be included, using water as a test medium. The pressures involved would range from atmospheric to about 15,000 psi, and the facility should be capable of producing as high a rate of flow as economically feasible during the opening and closing of the valve. The system had to operate automatically without the constant attendance of a testing engineer. The only difficulty this would cause would be in the pressurizing system which would automatically have to maintain a specific pressure at full flow and/or no-flow conditions.

[1] Chief Research and Development Engineer.

[2] Senior Research and Development Engineer.

Contributed by the Petroleum Division and presented at the Petroleum Mechanical Engineering Conference, Houston, Texas, September 20–23, 1959, of The American Society of Mechanical Engineers. Condensed from Paper No. 59—Pet-25 originally entitled "Specially Designed Equipment for Engineering Test Laboratory."

Facilities would have to be supplied for operating valves by rotation as well as by oscillation.

Pressurized-water supply, shop water, shop air, 220-volt electricity, and 2000-psi nitrogen pressure were to be made available to any point within the testing area.

A 50 × 80-ft space immediately adjacent to the Engineering Department was taken out of the shop area and enclosed by a concrete-block wall with an office, gage room, and destruction cell.

Destruction Cell

The destruction cell, Fig. 1, is 14 ft wide, 18 ft long, and 10 ft high. To allow crane entry, there is a door in the roof consisting of a hinged steel plate similar to the vertical main doors. The walls and roof are fabricated of 8-in. doubly reinforced high-strength concrete and have two bulletproof windows in two of the walls. Capped openings extend through the wall to carry control extensions and electrical connections out of the test cell.

Pressure Systems

The 100,000-Psi Pressure System. Since it was planned to use a 100,000-psi pressure system for static test work, the volume requirement could be extremely low. However, in high-pressure work, if a leak does occur, the test must be stopped if the pump capacity is not sufficient to overcome this leakage. A capacity of 2 cu in. per min was considered sufficient and permitted the pressure system to be built around commercial components. The primary unit is a 23:1 booster which gives an effective pressure boost of 20:1. The 5000-psi basic water pressure necessary to operate the unit was available, hence there was no trouble in reaching the 100,000-psi test pressure specified. The displacement of the booster is 1.08 cu in. per stroke, thus only 2 strokes per min were needed to meet the volume requirements. The pressure booster itself was a standard catalog item and required no adaptation for 100,000 psi.

The necessary stop valves, gages, fittings, and tubing were also standard commercial items for this pressure. The resulting unit was completely within the test cell.

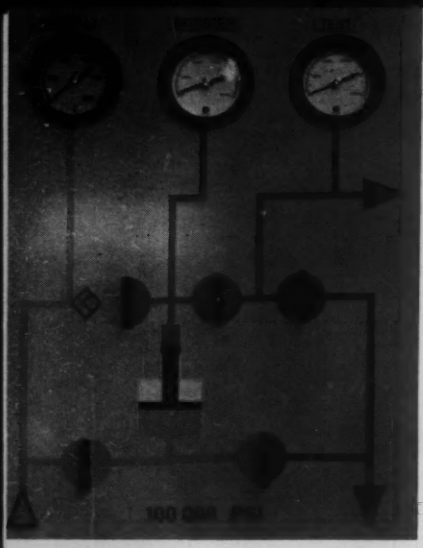


Fig. 2 Valves for the 100,000-psi pressure system are manually operated by extension stems protruding through the wall. The only high pressure outside the cell is in the pressure gages and their lines. The gages are protected by channel iron.

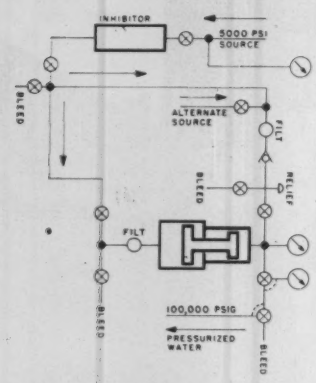


Fig. 3 Proper manipulation of the valves will alternately load and discharge the booster into the high-pressure line

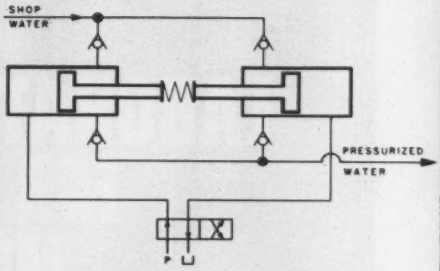


Fig. 4 Two cylinders placed in tandem with the rods facing each other, but separated by means of a spring, provide constant pressure of discharge water. Controlled valving achieves this through a cycle of single pressurization, double pressurization, and then reverse single pressurization.

The only high pressure outside the cell is in pressure gages and their lines, equipped with blow-out type backs and protected by channel iron to protect operating personnel. By manually operating this system from outside the cell, Fig. 2, and watching the equipment being tested through bulletproof windows, it is possible to control the test visually as well as by means of the gages. It can be seen from Fig. 3 that the proper manipulation of the valves will alternately load and discharge the booster into the high-pressure line.

General Pressure Systems. The general pressure system for cyclic testing of valves did not lend itself to an easy solution. One valve to be tested might require an operating pressure of 15,000 psi while another to be simultaneously tested might require only 275 psi, while as high a rate of flow as possible would be required for both tests.

The automatic-operation requirement really caused trouble. Small air-to-water booster pumps already in use automatically controlled the water pressure by inlet-air regulation, but fell far short of any reasonable flow rate, and consumed a very sizable quantity of air. More efficient pressure pumps of the multicylinder variety available on the market would give the required flow but did not have the precise pressure regulation required.

The use of a variable-speed electric-motor drive of the type commonly used on large machine tools for precise speed regulation, primarily in the aircraft industry, was considered. Pressure regulation within 1 per cent was more precise than necessary and the system cost would add up to about $15,000. Among other drawbacks, only one pressure would be available in the laboratory for test work, and a premium would be paid for the availability of 20,000 psi, while a great percentage of the testing would be at or below 1000 psi.

At this point, oil was considered as a test medium rather than water since many reasonably priced oil-pumping units were commercially available which are capable of automatically maintaining a given pressure up to the volume capacity of the pump. The combination of this source of regulated oil pressure and a transfer-boost cylinder to get the pressure to water might be a very satisfactory combination except for the fall to zero pressure when the booster or transfer cylinder was recharged. Finally, the combination shown in Fig. 4 evolved.

Two cylinders were placed in tandem with the rods facing each other but separated by means of a spring. After supplying these cylinders with a regulated source of hydraulic oil pressure, the shop water to be pressurized, and suitable valving and controls, the system was complete. It was designed to operate at the maximum of 1500 psi and uses a variable-volume constant-pressure hydraulic pump with a maximum working pressure of 1500 psi as a pressure source. The hydraulic fluid is fire-resistant and water-soluble. Any minor water leakage across the pistons into the hydraulic system would not be detrimental. The hydraulic cylinders are commercial units with rods as small as practicable in order to give nearly 1:1 pressure ratio between the hydraulic fluid and the pressurized water.

In action, the pressurized hydraulic fluid is introduced into the head end of one cylinder which pressurizes the entrapped water across the piston. The opposite cylinder is being recharged by the shop water forcing the used hydraulic fluid back to the reservoir. The pressure lines coming from the hydraulic pump to the cylinders pass through a 4-way spring-centered pilot-operated valve. In the center position of the spool, pressure is simultaneously applied to both cylinders.

Near the end of each pressure stroke, the piston rod actuates a switch which causes the operating valve to return to the center position, thereby pressurizing the hydraulic end of both cylinders. During this interim of double pressurization, the spring between the rods compresses, allowing pressure to be supplied to the system from both cylinders. After an adjusted time delay to allow the second cylinder to be brought up to pressure, the operating valve is cycled to the reverse position, allowing the formerly pressurized cylinder to be vented to discharge and hence causing a reversal of direction.

This cycle of single pressurization, double pressurization, and then reverse single pressurization continues and quite effectively maintains a constant pressure of discharge water up to the capacity of the hydraulic pump. With the proper spring size and time delay, pressure fluctuations in the order of 5 to 10 per cent are maximum when operating either at full flow or no-flow conditions.

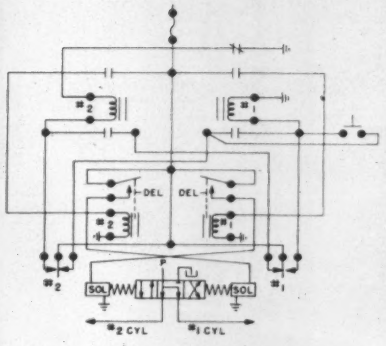


Fig. 5 Electrical circuitry provides the necessary time delays for bringing cylinders up to pressure and the various valve-control operations needed

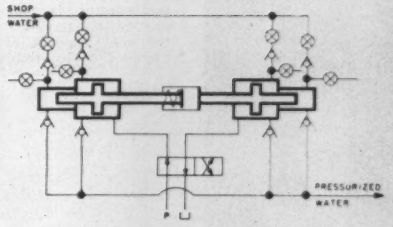


Fig. 6 The third pressure system designed for a maximum usable pressure of 15,000 psi has many features similar to the other tandem cylinder system

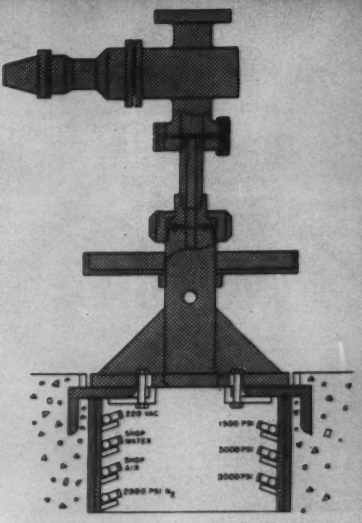


Fig. 7 Distribution of all laboratory facilities is via subsurface trenches, which also serve as drains, and as anchorages for test stumps. Angle-iron ledges provide rigidity and torsional stability.

At the full-flow rate of approximately 20 gpm, the stroke is reversed approximately every 20 sec. The hydraulic pump itself is driven by a 15-hp motor. Electrically, this unit is wired as shown in Fig. 5.

This combination of commercially available basic components resulted in a pressure system which would automatically maintain pressure regardless of flow while requiring a minimum of attention, at a cost of approximately $3000.

Three Pressure Systems Included. The low cost made it possible to extend the planning to include three pressure systems. The intermediate one consists of a duplicate source but uses hydraulic cylinders with the rods sized to give a 2:1 pressure boost between the head and rod ends. This permits an effective water pressure of 3000 psi at a maximum flow rate of approximately 10 gpm.

It was finally decided that the third system was to have a maximum usable pressure of 15,000 psi which necessitated some slight modification in catalog equipment and the basic arrangement. The hydraulic pump selected for this installation had a maximum capacity of 12.8 gpm at 5000 psi. However, it had only a 15-hp motor, hence its maximum capacity at 5000 psi was 7.6 gpm while 12.8 gpm could be obtained at 3000 psi or below. The 3:1 booster cylinders selected were again mounted coaxially; however, this time the pressurized oil was introduced into the rod end of the main cylinders. This made it necessary to rearrange the spring so that the relative movement needed between the cylinder rods at the stroke reversal would be possible.

The cyclic operation is the same as for the lower-pressure systems, even though the pressurized ends of the cylinders were reversed. Actually, the cylinders selected for this third system were in the booster class with double end rods which gave an additional advantage not obtainable from the straight cylinder operation of the two previous systems. As shown in Fig. 6, water could be piped into either the large cylinder itself or into the booster section. When using the large cylinder, a ratio of 1:1 or 5000-psi maximum pressure was obtained, while the booster produced a 3:1 pressure ratio or 15,000-psi maximum. That part of the booster cylinder not being used is vented to atmosphere to prevent a pressure lock.

The piping connecting the hydraulic pumps to their respective booster systems is so manifolded that the output of all pumps can be directed to any one booster. Thus the volume output of any particular system can be increased as long as the maximum hydraulic pressure of that system is not exceeded.

Distribution Systems

The distribution systems for all laboratory facilities are housed in rectangular subsurface trenches, 13 in. wide and 16 in. deep, designed for multiple-purpose usage. The floor of the laboratory has been sloped to effect a drain into the trenches and the bottom of the trenches themselves is sloped into a sewer-line inlet.

The upper edge of the trench terminates in an angle-iron ledge which is located below the floor level to support removable gratings which are flush when installed. These angles, Fig. 7, also serve as an anchor for the test stumps. This angle-iron ledge is secured into the concrete floor by means of reinforcing bars to make it as rigid as possible and to obtain torsional stability.

The base of the test stump, Fig. 7, is square in shape so that it may be set within the angle-iron ledge at the top of the trench and is secured by sliding clamps attached to the lower side of the base and engaging the angle iron. There are outlets in the lower column of the test stump for attaching pressure lines, gages, and bleeds to a central passageway to the top. The connecting pressure lines are usually in the form of hoses with quick-disconnect ends. The top adapter is connected to the lower column with a hammer-lug union and sealed with an O-ring. There are four pins outside of the O-ring for alignment of the test unit and to prevent rotation of the top adapter. This adapter was made in two styles, the first incorporating a 2-in. male thread for threaded valves or flanges and a 1-in. female thread for smaller units. The other style incorporates a shoulder for attaching large flanges by welding. There is a tool tray which can be mounted around the outside of either the lower stump or top adapter. It is hinged to facilitate removal and can be clamped in any height on the test stump.

The stands, Fig. 8, used in mounting the various types of valve operators are attached to the trench in the same manner as the test stumps. These units are so constructed that the top mounting portion, holding the operator,

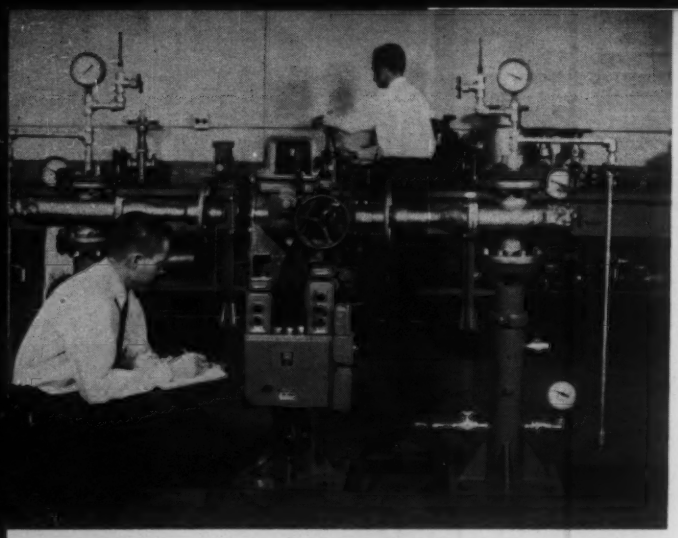


Fig. 8
Stands used in mounting the various types of valve operators are attached to the trench in the same manner as the test stumps. The top mounting portion telescopes into the lower column and can be clamped at any required height.

telescopes into the lower column and can be clamped at any height required. The power to drive these operators is obtained from the 220-volt lines in the trench through waterproof connectors.

Valve Operators

The valve operators required for cyclic testing of valves fall basically into two types—those which produce controlled rotation, and those capable of 90-deg oscillation. Both types are required to operate with either position or torque limits. Commercial units were usable for both types.

A rotating-stem type of valve, Fig. 8, uses a standard electrical valve operator with built-in torque and position controls. When rewired, this unit is capable of automatically cycling valves with adjustable delay times at each end of the cycle recording the number of cycles and incorporates an operational monitoring circuit. In the event of a failure the test is automatically stopped without the attention of a testing engineer.

The test setup for oscillating-valve operation consists of a commercially available hydraulic-vane-motor unit which has its rotation limited to approximately 90 deg. This unit is attached in the center of a line shaft extending parallel to one of the trenches. Crank arms with push-pull connecting rods can be attached to the shaft at any point to operate a valve. The operating medium is the hydraulic oil from one of the pumping systems which passes through a flow-control valve for speed regulation while the torque is controlled by the pressure of the hydraulic system. The maximum torque output is approximately 1600 ft-lb at 1000-psi oil pressure. The cycle-delay and test-monitoring systems mentioned are also used in conjunction with this operator.

Strain-Gage Equipment

Various types of commercially available strain-gage equipment are on the market:

1 The manual null-balance, static-strain indicator with a switching box is capable of handling a multiplicity of strain gages. It is relatively inexpensive and highly portable; however, considerable time is consumed and possible errors are introduced as a result of switching from one gage to another, recording these points, and doing the arithmetic involved.

2 A semiportable recording-oscillograph unit can be used for static or dynamic multiple-channel work and produces actual curves of the strains involved. However, the cost is $5000 to $8000 for eight channels, and setting up is very tedious. In addition, a large number of recorded channels can be very confusing on one sheet of paper. Interpretation and analysis of results are even more lengthy and approximate.

3 The scanning type of digital logging system has the advantage of being semiportable and capable of handling quite a large number of channels at a moderate cost, and direct read-out reduces the possibility of error.

Digital Logging System

A specially designed digital logging system was decided upon as being the type which would be primarily useful. It affords a means of handling a great number of channels in a short period of time and the results are obtained directly in units of apparent stress. Using this unit it is now possible to obtain quite an elaborate strain-gage study in a matter of 2 or 3 hr which formerly took at least 2 or 3 days. The results can be monitored immediately, almost eliminating the rerunning of tests.

The only outside connections to the digital logging unit are the strain gages themselves and 110-volt a-c supply. The active strain gage is one arm of a Wheatstone bridge while the adjacent arm is another strain gage used for temperature compensation. When it is desired to make a test, the gages are put in place on the test item and each of them is connected to the logging unit. Each gage is balanced to zero and the gage factor of the particular gage being used is set on a gage-factor control. The calibration switch is set at 50,000 psi, and the gain control is then adjusted until 50,000 psi reads on the stress dial. A given strain in the gage then shows its corresponding stress when the gage is on steel.

In the event another material is being tested, the 50,000-psi stress is merely multiplied by the ratio of the modulus of elasticity of the material being tested to that of steel and the dial set at this new stress during calibration. The printer prints out both the channel being recorded and the value of the stress.

In an actual stress run, the unit requires a little less than 1 sec per point being tested. A run of 40 strain gages can be made in approximately 35 sec. There are also jacks in the unit into which an oscilloscope can be connected for dynamic observations on an oscillograph for dynamic measurements. The unit also can be used with differential transformers for linear measurement; and if used with a sequence timer, it can record stresses at predetermined times while unattended.

The maximum and average unit kilowatt-rating increases are shown on the graph. In the background is a view of the Public Service Electric and Gas Company of New Jersey's Linden Station. The two 3600-rpm, tandem-compound, triple-flow, G-E turbine-generators (one reheat, one nonreheat) are extraction units with conductor-cooled generators.

By Glenn B. Warren, Past-President, The American Society of Mechanical Engineers
Vice-President and Consultant, Turbine Division, General Electric Company, Schenectady, N. Y.

What may be ahead in POWER PRODUCTION

Twenty years from now, you may find the expanded power output still produced largely by fossil-fuel steam plants, the nuclear plants producing 10 per cent. As to the exotic developments, such as the fuel cell? Yes, with limitations.

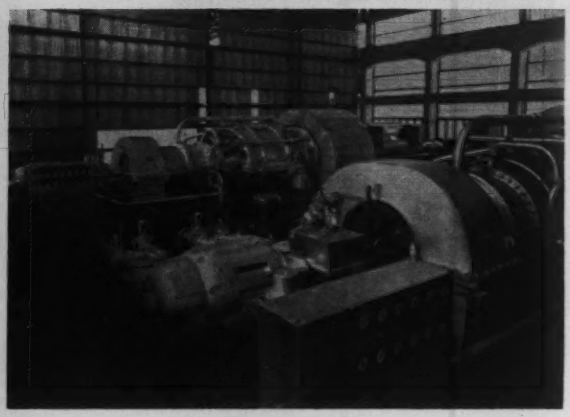
THERE are some who feel that technical progress in the power business has slowed down. True, we are beginning to reach the point of apparently diminishing returns on higher pressure, higher temperatures, new steam cycles, and so forth, and instead of 3 per cent per yr reduction in fuel consumption we are having difficulty visualizing 1 per cent per yr. This makes many feel discouraged with the outlook for continued technical progress, despite the tremendous promise and challenge of the capacity factor alone.

Electric power is attaining ever-increasing importance, and an ample supply of low-cost electric power is a vital necessity to an industrialized nation. Without it, a high degree of progress and a high standard of living cannot be attained. However, a common misconception a few years ago was that the principal thing an underdeveloped nation had to do to acquire a higher standard of living was to have more low-cost power available, and cheap atomic power was hailed as the development that would do this. Philip Sporn was the first to point out that an industrial nation needs six to eight dollars invested in industrial power-using capital-goods machinery for every dollar invested in power-producing machinery to get in position to use the power efficiently for its productive purposes. This indicates that power alone, although important, is not the only need of the undeveloped parts of the world.

Not only has peak load and capacity doubled about every 9 to 10 years during the 70 years or so of the industry's growth, but the average fuel consumed per

Based on a Luncheon Address at the National Power Conference, Kansas City, Mo., September 27–30, 1959, sponsored by the Power Divisions of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS and the American Institute of Electrical Engineers.

What may be ahead in POWER PRODUCTION



Two G-E 16,000-kw, single-shaft, simple-cycle gas turbines are installed at the Planta Electrica de Grupo Industrial, Monterey, Mexico

kwhr has been reduced almost 3 per cent per yr over that period. The electric power industry is still rated as one of the great growth industries, and, despite the fact that it now costs 2 per cent of the total national income, for at least the next two decades it will maintain its rate of growth in physical capability.

This would result in a fantastic 600,000,000 kw of installed capacity by 1979, and our national power bill would probably be 5 to 6 per cent or so of the total national economy. This would mean that three times as much generating capacity would have to be installed in the next 20 years as in the past 70 years. The problems of fuel supply and ash disposal, stream heating and condenser-water supply, and radioactive-waste disposal would be fantastic and an important part of the problem. Whether the competitive drive of other forms of energy and the pressure of costs on efficiency of utilization will permit this degree of growth or not, it will still be very great. Even if it is not 4:1, it will certainly be 3:1 in the next 20 years, and the difference will be of little real significance.

Role of the Steam Turbine

There is much reason to believe that the large steam-turbine fossil-fuel-fired steam-boiler power plant will be used to meet the bulk of the electric-power needs for a minimum of 20 more years. Water power plants will be developed as the years go on, but all the evidence seems to indicate that they will be furnishing a decreasing percentage of the total power, certainly not much more than 20 per cent of the new growth ahead. Fission-fuel nuclear power plants will be developed to take an increasing percentage of the load, but even the most enthusiastic supporters of these projects would not expect to have more than 60,000,000 kw installed in nuclear power plants by 1979, and this would then be but 10 per cent of the total. Therefore in view of the enormous kilowatt capacity that will be installed in fossil-fuel-fired largely steam-turbine power plants, even minor improvements in economy will be of great importance.

The reliability and maintenance of both boilers and turbines are beginning to be of even greater importance than in the past, not only because of the size of the units, but on account of the changing character of the load. Before the widespread use of air conditioning, almost all power companies had a low-load period in the summertime. They had but one peak per year, namely, in December and January. This usually gave them ample time for maintenance and overhaul during the low-load period in the summer. The two nearly equal peaks which most power systems in the middle latitudes in this country now have—one in summer and one in winter—usually allow little time for overhaul and maintenance, and necessitate greater reserve capacity unless the maintenance outage time can be greatly reduced.

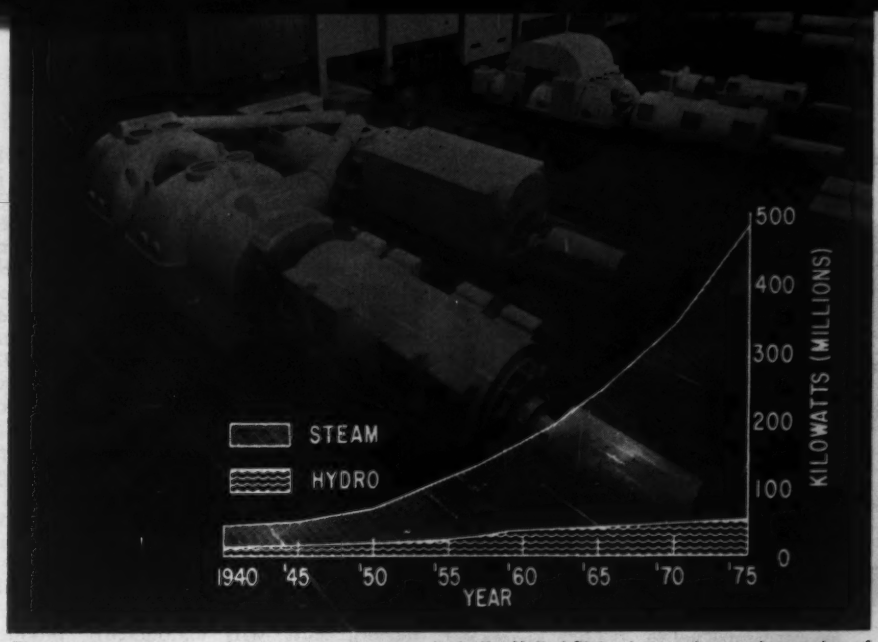
The Gas Turbine

The gas turbine is a new power tool which will probably have increasing application. It is rapidly developing into a reliable machine, but for rather specialized applications. In capacities of 5000 to 25,000 or 30,000 kw per unit for burning oil or gas fuel, it is quite probable that it could now compete in every respect on an over-all cost basis per kwhr with steam-turbine plants. Unfortunately, this is an area of plant size decreasing in importance in this country for straight power plants due to the growth and interconnection of power systems. In the foreign field, however, it is quite likely that the highly efficient regenerated gas turbine in higher-fuel-cost areas, and the simple-cycle unregenerated gas turbine in low-fuel-cost areas may fill an important niche between the diesel-engine generator and the large steam-turbine generator.

In this country, the gas turbine is expected to meet two important needs in connection with the generation of power. In combination with high-pressure, high-temperature resuperheated steam plants, it can be used as it is being used in a few moderate-sized plants today—placed ahead of the boiler furnace, with the gas-turbine exhaust discharging into the boiler furnace to be mixed with fuel. The excess oxygen is used in such a way as to increase the over-all capability of the plant about 15 per cent, and the economy, that is, the total fuel consumption per kwhr, improved by 4 to 5 per cent.

The second way it may be used, and technically it could be done so today with oil or gas fuel, would be to supercharge the boiler by using the boiler furnace as the combustion chamber for the gas turbine operating at a pressure of 5 to 6 atm abs. This could increase the capacity of the plant by 15 per cent or more, and improve the economy from 6 to 8 per cent. The problems of burning coal in such a plant are formidable, but not insurmountable, and certainly will be solved within the next few years.

Another application for gas turbines and one which should make an important contribution to the lower future cost of power will be as automatic peak-load plants. With the tremendous growth of the power business, the diminishing rate at which new plants are improved in economy, and the resultant larger percentage of highly efficient steam plants on a system, it is no longer as practical as formerly to use old and inefficient steam plants for carrying the peak loads. The cost of manning these older plants for peak-load service is an important part of the cost, and the self-contained automatic-operation potential of the newer peak-load gas-turbine plants may be important. These will probably range from 20,000 to 30,000 kw per unit—with larger



The total hydroelectric and steam generating capacity in the United States is superimposed on a view of Detroit Edison Company's St. Clair Station. The steam turbine-generator in the foreground is a G-E 325,000-kw, 3600/1800-rpm, cross-compound, double-flow reheat unit. Steam conditions are 2400 psig, 1050/1000 F.

units in a few years if needed—and such units can probably be located strategically on a system in such a way as to greatly reduce the power-transmission costs. If a sizable business should develop in these plants, they can be highly standardized to reduce materially the cost of production.

Time to Consolidate Gains?

Returning to the probable development and application of the large steam plant over the next few years, it should be borne in mind that the average and maximum temperature at which such plants have been built and projected has increased about 12 deg per yr for the past 55 years. Much money and effort have been expended by turbine manufacturers, boiler manufacturers, and users in an effort to keep this rate of advance. Unless a new break-through can be found in the way of lower-cost, high-temperature materials, costs of each advance beyond about 1050 F in the initial temperature, and possibly this or 1000 F in the resuperheat temperature, gain less and cost more than previous increases in temperature. The point has been reached where the cost of such further advances quite definitely outweighs the capitalized value of the gains. This is a serious situation. The records of the newer high-temperature machines in service need also to be studied carefully to determine whether or not the maintenance and outage have been unduly increased. Such plateaus in the increase in temperatures have existed before, and perhaps there should be a pause here for a few years to consolidate gains, and let the development of basic materials and their fabrication catch up with newer needs.

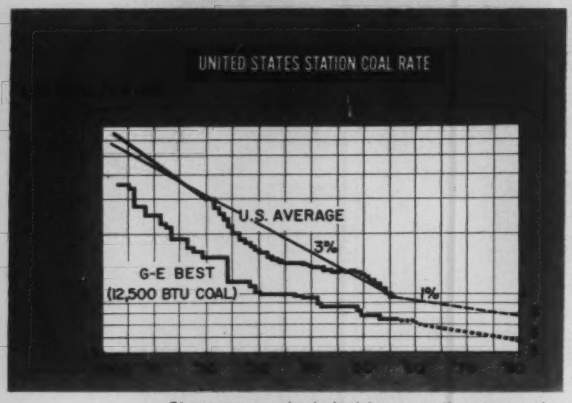
The same thing is to some extent true in connection with high pressures. Pressures, like average machine capacities and total electrical loads, have doubled approximately every 12 years for the past 50 years. Here again, there seems to be a tendency to pause on the development at about 2400 psig, with boilers having drums. If the newer drumless boilers bear out their present promises, it is quite likely that economical pressures for machines of 200,000-kw capacity and above will reach into the region of 3500 to 4500 psig. This will certainly be true if it proves practical to operate these boilers at somewhat reduced temperature at maximum load, and at reduced pressures at lighter loads. Such operation should simplify the piping problems and the turbine-design and control problems, and give the maximum possible utilization of all of the equipment.

Larger Turbine-Generators

There seems to be every reason to believe that the average size of the boiler turbine-generator unit for these large fossil-fuel-fired plants will continue to increase in the next few years. Due to the growth of systems and interconnections, the bulk of the units being ordered now are in the neighborhood of 200,000-kw capacity, with 300,000, 450,000, 500,000, and even 600,000-kw units on order. Technically, there are no reasons why units of 700,000, 800,000, or of 1,000,000 kw cannot be designed and built. This will have to be resolved in the years ahead on an economical basis, taking into account the probable diminishing gains in economy and first cost of units as the size continues to increase. Much of this will come about by multiplying the basic building blocks of the boilers, piping, turbines, and generators. Of course, the larger the unit the greater the cost of the reserves which must be maintained against its outage, and the less flexibility in the system operation.

In these large units, there is a trend which, in the author's opinion, has been in the wrong direction, and which will probably be changed in the next few years. This is the tendency toward getting an unduly high maximum capability out of a given exhaust end on the turbine, and out of the given condensing system. Much of this has been made possible on an entirely proper basis with the increases in pressure, temperature, resuperheating, and extraction of steam for feedwater heating, all of which give a greater specific capacity for a given flow to the condenser. Still, however, the high energy in excessive exhaust losses is thrown away and can never be recovered. The recovery of a given number of kwhr here at zero fuel cost would probably be less

What may be ahead in POWER PRODUCTION



Steam power plant electric-generation economics are extrapolated to 1980. The U. S. average and the G-E best station coal rates are compared.

expensive than such recovery in the high-pressure, high-temperature end of the system, for which there has been so much effort, expense, and a willingness to take risks.

Much of the pressure for this increasing rating has come about from the desire to get larger and larger capacity from 3600-rpm turbine-generators whose ceiling has largely been lifted by the development of internal cooling. On the other hand, in the high-pressure end, intermediate part, as well as in the low-pressure last-stage area, the 3600-rpm turbine is probably being forced in the range of 300,000 kw and above per unit into an area for which it is not as well suited as a lower speed turbine. This is true particularly in the exhaust end, and for this reason the cross-compound, 3600/1800-rpm turbine-generator will probably take on increasing importance in the 200,000 to 400,000-kw range. Above this capacity, single-shaft, 1800-rpm, tandem-compound turbine generators, and cross-compound turbine-generators, all at 1800 rpm, will probably assume an increasing role.

The inherent advantages of the 3600-rpm machine over the slower-speed machine at higher steam conditions continue to exist up through 200,000 kw for single-shaft machines, and probably to 400,000 kw on two-shaft, cross-compound machines for high pressure at 3600 rpm. Where the low-pressure end of such turbines is run at 3600 rpm, multiple exhausts must be used above 50,000 kw. Here again, adding still another exhaust flow in multiple with the existing last-stage bucket-length design may be wiser than attempting to go to the maximum possible physical limit on last-stage-bucket dimensions for 3600 rpm, both from the standpoint of economics, and maintenance and reliability.

The Fuel Picture

From the standpoint of fuel for such large fossil-fuel-fired plants, this country has been and will probably be in a fortunate position for a great many years. Fuels such as gas, oil, and coal have been in plentiful supply and relatively low in cost. Continuing new discoveries of oil and gas, reduced transportation costs of these fuels by pipeline in competition with rail carriers, and available foreign supplies of oil have kept prices relatively low. Increased efficiency with which coal has been used, the competition which it has faced from oil and gas in many of its fields of application, and the dieselization of the railroads have all caused the usage of coal to stay well below previous peak outputs, despite our increasing over-all energy use. Increasing mechanization of coal mines has offset increased wages to a great degree, with the result that fuel costs to central stations per million Btu have not increased over the past several years as much as the general price increase of other commodities. This is not likely to continue, and for the next 5, 10, or 20 years the cost of fossil fuels for electric-power generation may increase relative to the cost of other commodities. This would put an increasing premium, as the years go on, on designing and producing still more efficient power plants, and the efficiency of fuel utilization in the plants currently being planned will be of increasing importance over their lifetime.

Another fuel which will attain increasing importance will be that from atomic fission. Present and future developments will undoubtedly produce lower-cost, more-efficient, higher-output fission-fueled plants. Problems of higher pressure, temperature, and resuperheating will certainly be solved. Although these first costs and fuel costs now appear higher than in conventional plants, future reductions in costs, slower rates of improvement in the efficiency of fossil-fuel-fired plants, and increasing costs of fossil fuels will all tend to make fission-fuel power plants competitive in many areas of this country.

Other Forms of Power Production

Among the more exotic developments under way, thermoelectric production of power is simply the old and familiar thermocouple utilizing some of the new semiconductor materials and set up in multiple to generate power from a series of hot and cold junctions. It is limited to the production of low-voltage d-c power with efficiencies of 8 to 10 per cent and potentially about 30 per cent. The fuel cell, on the other hand, may eventually reach an over-all thermal efficiency of 60 to 80 per cent—well above the 45 to 50 per cent apparent potentiality of the steam-turbine gas-turbine cycle. Fuel cells also are limited to large quantities of low-voltage d-c power. Conversion to a-c would be costly, and fuel cells are probably going to be more choosy with respect to their fuels than gas turbines have ever been. The thermionic cell which generates an external electric flow by the electric voltage potential resulting from ion flow through a temperature differential—usually in a vacuum-tube like device—may attain efficiencies in the 30 per cent range and has other limitations.

All three of these heat-to-power devices present potentialities for use as a topping cycle on a high-pressure, high-temperature steam cycle, much as the mercury cycle was used two decades ago. As such, they may offer an opportunity for increasing the capacity of a given steam-electric power plant by 30 per cent or so and increasing the over-all thermal efficiency as much as 15 per cent. But, again, they will supplement, not supplant, the steam turbine-generator combination.

Fusion power obtained by the basic conversion of appropriate forms of hydrogen to helium offers a potential supply of energy said to be almost beyond our power of comprehension. Certainly if it can be achieved, this will be the solution to the increasing energy needs and

the decreasing fossil-fuel supply in the decades and centuries ahead. For some reason or other—probably instinctive—the possibilities of success in attaining this energy conversion on a continuous basis, with its fantastic requirements of pressures and temperatures in multiples of 100 times or so of those which have ever been attained in practical apparatus, leaves the author somewhat cold, to use a peculiar expression.

On the other hand, an explosive utilization of this energy has already been attained in the hydrogen bomb and there is the possibility that this energy can be harnessed through the use of underground explosions to produce high-pressure, high-temperature steam on a more or less continuous basis. Its use in that manner to recover otherwise unworkable oil reserves may offset the factors tending to increase the cost of fossil fuels and postpone for a generation or two the anticipated depletion of these supplies. Underground gasification, incidentally, is another potential aid to the fossil-fuel problem.

A field to which increased attention should be given in the years ahead is the integration of power generation with furnishing heat to industrial and urban space-heating. There are economies in fuel to be gained and there is less need to throw away heat to the condenser. The Germans and Russians have gone much further on this than we have.

An Outstanding Industry Problem

There is widespread discouragement in the power industry regarding the ability to attract outstanding, imaginative, and resourceful young men in the face of the presently more glamourous fields of electronics, aeronautics, missiles, space science, and—fortunately for the power industry—atomic power.

There is no panacea for this situation, but a number of steps are available.

Top-level people, particularly engineers in the power industry, should take more interest in education, both at the college and high-school level. Some of the power courses at engineering schools are probably woefully behind the times and they could help to modernize them. At the high-school level, the boys need to know the importance and the growth potentialities of the power business.

Summer employment properly planned, guided, and offered to high-school juniors, seniors, and college-undergraduate engineers would go a long way toward making these boys want to come back after graduation.

Assistance to college graduates in getting advanced degrees is a tremendous drawing card. Making early work assignments more interesting, rewarding, and challenging will be a help both in recruiting and holding good men. Seeing that the men taken on are given increasing management opportunities, as well as increasing engineering opportunities, will go a long distance toward attracting and holding good men. Word regarding these things gets around among the college boys very fast.

Then, if pioneering activities can be deliberately stepped up, better men will be held. One of the largest and most successful electric utilities in this country, in reply to a stockholder question, recently stated that they were doing an amount of research, other than nuclear, that was less than 0.1 per cent of their gross revenue. This is probably not enough.

In addition, if the situation is to improve, every possible effort should be made to further a young man's professional growth through technical and professional-society activities, such as participation, presentation of papers, national committee work, and local section activity.

A salary structure, competitive in all details with the other opportunities he will have, should be worked out.

Another opportunity is to watch carefully for the times when engineers may not be in such tight supply, as in 1949–1950, and again in 1957–1958. Such situations will occur again, particularly if there should be another temporary recession or let-up in the pressure on defense. With the certain growth and stability that exist in the power business, such periods should be golden opportunities to step in and take on some outstanding young engineers.

Analyzing Future Trends

To take a good look at the future in any technical field such as that of electric-power development, one needs to make a careful appraisal of the current and popular apparent trends and then take a look at current basic developments. It may be that, in regard to what currently seems to be the trend, in the words of a popular song, "It Ain't Necessarily So."

This has application to the size and speed of steam turbine-generators for electric-power production. Originally these were built at 720 rpm, then 1200 rpm, then 1800 rpm, and finally at 3600 rpm. A ceiling was put on this increase in rotative speed by the use of 60-cps power. Then larger and still larger turbine-generators were built at 3600 rpm and many felt, and some still feel, that despite the increasing difficulties of adapting the 3600-rpm turbine-generators to the extremely large unit sizes now becoming more prevalent, that growth in the output of these high-speed machines was inevitable.

A reappraisal of all of these factors, and developing experience with high-speed single-shaft turbine-generators as compared to the experience with the newer cross-compound turbine-generators with 1800-rpm low-pressure units may change this. These may well indicate that together with better utilization of the low-temperature end of the cycle a swing back to the 1800-rpm machines may be the proper move for the future from many standpoints.

Ten years ago, a large number of well-informed people were firmly convinced that the continuing development of the fossil-fuel-fired steam plant would shortly come to an end and a large percentage of the new plants would use nuclear fuel. The cost of development, the increasing realization of the relatively high cost of the fission fuel, and the moving target of the continuing improvements in the fossil-fuel-fired steam plant now make it appear that the fossil-fuel-fired system is far from the peak of its development and use as a power producer.

The sheer magnitude of the future power development in this country, and a realization that a parallel power-systems development, starting where the U. S. was 10 to 50 years ago, is just getting under way in the rest of the vast majority of the countries of the world, offer material for much thought. The great future power development needed here and throughout the world to serve a population more than 12 to 15 times that of this country on an efficient and proper basis remains one of the greatest challenges that faces engineering and management today.

How should engineering education face up to the needs of the new era?

TOMORROW'S ENGINEERING EDUCATION

By A. H. Shapiro,[1] Mem. ASME
Massachusetts Institute of Technology, Cambridge, Mass.

We are in the early stages of the third great revolution in the material circumstances of man.

The first revolution—the agricultural revolution—made it possible for men to put down roots and build societies and cultures as we now know them.

The second—the industrial revolution—has led to our present fabulous standard of living. Its most important invention has been the concept of, and the faith in, invention itself: That men could contrive machines to make life more comfortable. But when we look at such names as James Watt, Cyrus McCormick, Eli Whitney, Thomas Edison, and Henry Ford, we realize that the great forward steps were based not so much on scientific ideas as on imagination and tinkering ingenuity. Professional education contributed very little.

[1] Professor of Mechanical Engineering.

Based on an address delivered at the Hydraulic Dinner of the Annual Meeting, Atlantic City, N. J., November 29–December 4, 1959, of The American Society of Mechanical Engineers.

The Third Revolution

In the first half of this century, a distinctly new pattern began to emerge, a pattern which portends a revolution. The astonishing technological feats of this era are beyond all that invention, ingenuity, and tinkering could accomplish by themselves. Such technologies as flight, electronics, and nuclear power have come about through a fusion of deep scientific skills with purposeful engineering motivation.

As in all revolutions, an important element is faith—in this instance, faith in a new set of convictions. The new convictions are that technological progress need not move in slow and measured steps; that great forward leaps are possible through research and development; that while such efforts often represent a gamble in which money and time may go down the drain, statistically the operation is a good bet. We have seen, for example, enormous pay-offs in air transport and in all the miracles of electronics communication.

This science-engineering revolution has consequences which must be acted upon by schools of engineering.

The time period between scientific advances and their useful exploitation has been enormously condensed.

Completely new technologies reach maturation in a decade or less, while older ones take a back seat or disappear. Education in a particular technology was once good for a lifetime; now it is not.

The massive research and development efforts now so important suppress distinctions between scientific and engineering activities. It requires men who can learn and work in a succession of technological areas. By leaping across boundaries of disciplines, it has largely obscured the categories of "Civil Engineer," "Mechanical Engineer," "Electrical Engineer," and so on, the reflections of the industrial structure of fifty years ago.

Research and development now constitutes in itself a vast new industry—perhaps the most rapidly growing of all. The depth and breadth of scientific knowledge required to operate as a professional in this industry are far in advance of the traditional engineering education.

Once, the schools' task was simple: To train men to do particular jobs, in the belief that this training would be relevant during a professional lifetime. Now they must educate young men to be effective in a succession of future technologies whose very forms are now unknown to us.

Guide Lines

An engineering education must be liberal in the classical sense. It should free the intellect of orthodoxy and narrowness of outlook. It must not produce the inhibitions of which so many forms of traditional engineering education have been guilty.

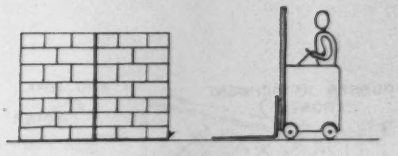
The liberal base of an engineering education is science. One of the chief problems is to establish this base securely while at the same time preserving the motivations and responsibilities of engineering.

Training a man skilled and ready to take his place in a branch of the existing arts is no longer desirable, nor for that matter is it possible in a truly professional education. Versatility and adaptability are essential.

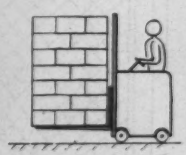
We must be prepared to undertake bold experiments, in keeping with the revolutionary nature of the new needs. Small steps may never reach a receding goal.

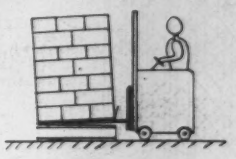
Not the least problem is the intellectual and psychological readiness of the faculties of schools of engineering. This requires even more attention perhaps than the problems of curriculums and students.

A step forward in the warehousing of case goods, the finger rack may eliminate the pallet.



WAREHOUSING WITHOUT PALLETS





By Irving M. Footlik, Mem. ASME

President, Irving M. Footlik and Associates, Skokie, Ill.

THE pallet and fork-truck method of handling goods, widely used in industry, has led to considerable savings. With the constant increase in the cost of labor, it becomes apparent that even the handling of pallets is a problem. In an average warehousing operation as many as 100 pallets may be handled in a day. These weigh from 60 to 100 lb and represent an unproductive handling of anywhere from 750 to 1250 lb per man-hour which can be eliminated with palletless handling. In a year's time these savings can be considerable.

The Palletless Concept

The entire concept centers around the use of a lift truck with a front-end take-it-or-leave-it attachment, Fig. 1, that is designed around the principles of the human hand. There are eight fingers. The two outer ones are higher than the rest and are welded to the frame. The remaining fingers float on a loose bar and can be flexed.

There is no movement in a downward direction; therefore, when picking up a load, it is cradled. This cradling action forces the outer row of cases to lean toward the center and tightens the load so it doesn't fall off the forks. The Kroger Company has developed this principle for handling groceries, possibly the fastest moving tonnage in all industry. The equipment can be adapted to other industries.

The original Kroger concept has been modified by making the two outer forks 1 in. longer, fully tapering all forks so each finger touches the ground. This makes it possible to drive under a load of material, using the two outer forks for the chisel action, while the remaining inner forks follow underneath.

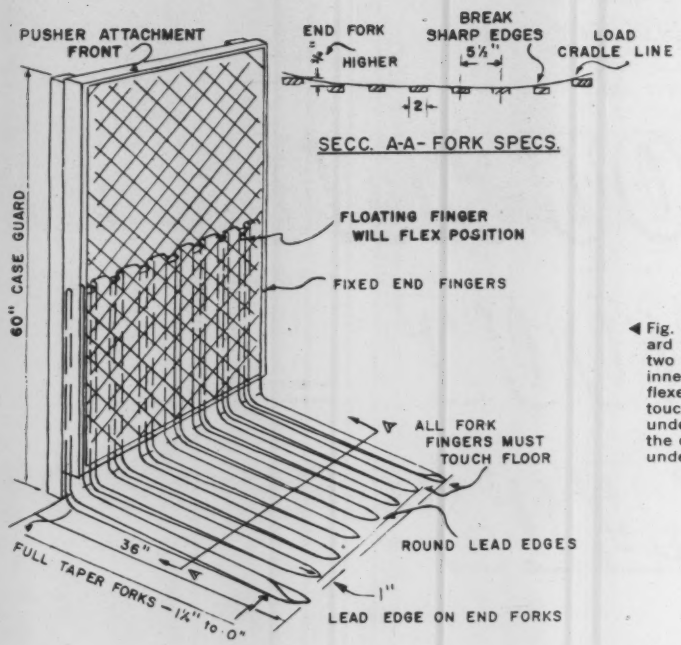
A palletless finger rack of the design illustrated in Fig. 2 is the second piece of equipment and is designed around the cantilever principle. Loads placed upon the finger racks are set upon these racks with the multiple-finger lift-truck attachment. The loads can be removed with the same equipment.

The weight of the load is supported by a rail set under the center of gravity of the load. Therefore the cantilever arms extend under half the load.

The use of this design for a storage rack makes it possible to increase the capacity of the rack 10 to 15 per cent. It reduces the height to which a man has to pick and also reduces the over-all rack cost since the cantilever design instituted in Fig. 2 requires a minimum amount of steel—actually no more steel than would be required in two standard racks placed back to back.

The end rails are fully adjustable, allowing the beds to be set at any height desired. The use of one, two, or three beds varies with the installation. The design can

Contributed by the Materials Handling Division and presented at the Annual Meeting, Atlantic City, N. J., November 29–December 4, 1959, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from Paper No. 59—A-315.



◀ Fig. 1 The "take-or-leave" attachment for standard fork trucks has eight "fingers," or forks. The two outer forks are welded to the frame while the inner ones are attached to a floating bar and can be flexed. All forks are fully tapered so that each finger touches the ground. Thus it is possible to drive under a load of material, using the two outer forks for the chisel action. The remaining inner forks follow underneath so the load of cases can be picked up.

also be modified for whatever capacities are desired.

The third piece of equipment, Fig. 3, is an order-picking truck with spacing on the deck to allow for insertion of the lift-truck forks. It has been modified from the original Kroger design to fit multiple installations for various industries. The load can be removed from its deck without manual handling.

The final piece of equipment required is a lift-truck attachment that was developed by the Cascade Manufacturing Company and Little Giant Manufacturing Company, and is known as the Turn-a-Fork. It is a combination fork-and-clamp design for multiple material-handling operations. The two arms have a high-friction rubber-faced surface and can be tilted from one position to another without the driver leaving the truck. Similar equipment is available from all lift-truck manufacturers.

Using the Equipment

Loading Boxcars. Boxcars can be loaded in standard unit loads consisting of piles of case goods set up in 48 × 40-in., 32 × 40-in., or a 36 × 48-in. pattern. These case goods are set on a sheet of corrugated board with a 4-in. lip. This board should be of 250-lb test or better. The car can be loaded with either a standard lift truck with multiple forks or a pull-pack truck which is designed with broad fork blades and a pusher bar. The size of the sheet of cardboard is predetermined by the customer and is set up in accordance with the pallet size used in the customer's warehouse.

Where the supplier is not equipped to load a boxcar with mechanical equipment, the cases can be loaded directly on the sheets within the car, using a pattern that would allow removal with mechanical equipment.

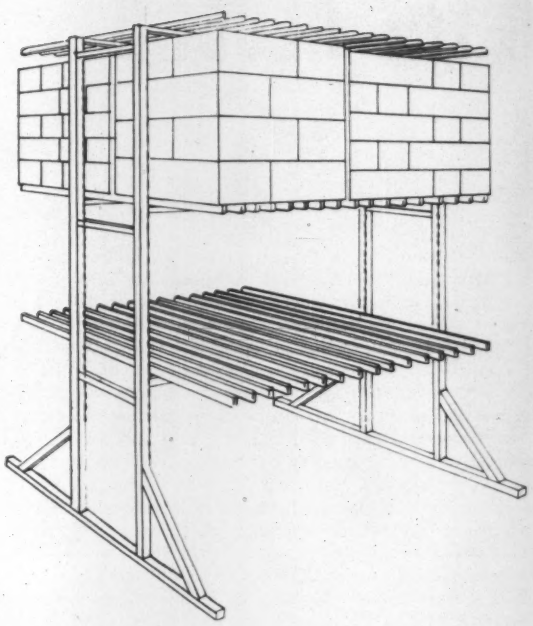
At the destination, case goods can be removed by going into the car with a lift truck having standard saber forks which permit going directly underneath the load, taking it from the car, and setting it on a pallet or stack within the warehouse.

In places where goods are picked directly from this stack there is definitely no need for a pallet, especially if this is used in conjunction with either a pull-pack attachment or some of the new clamp attachments to be mentioned later.

The pineapple growers have already inaugurated a program of shipping directly to the consumer's warehouse in unit loads. They have adopted a standard 48 × 40-in. unit-load pattern with a 72-in. height. The illustration shows the manner in which unit loads are placed in a refrigerator car, with lift-truck equipment removing these same unit loads from a car and placing them on pallets or directly on the floor.

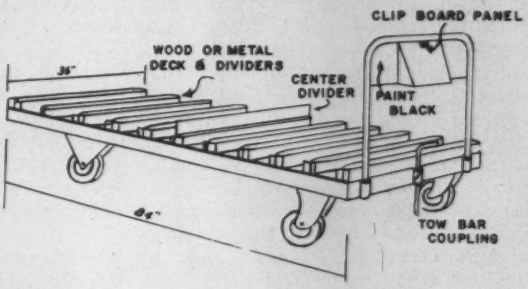
The same principle, utilizing a sheet of corrugated board to divide the load into a size of unit that can be handled economically, can be used for loading and unloading highway trucks.

Loading Highway Trucks. The floor of the highway trailer can be marked into 32 × 40-in. and 48 × 40-in. loads. When loading, sheets of cardboard or kraft paper are placed between these loads. The 8-bladed saber fork-lift truck illustrated, with the two outer blades lower than the inner blades and the forks tapered down to a knife edge at the point where they touch the floor, allows driving these forks directly underneath the load. This works especially well where the floor is of



◀ Fig. 2 This palletless storage rack has a capacity of 4000 lb per opening on the top deck (two units high) and 2000 lb per opening on the lower deck (one unit high). The lower deck vertical opening is adjustable. Loads are set on the rocks by the multiple finger "take-or-leave."

▼ Fig. 3 A palletless order-assembly truck of 4000-lb capacity. The load can be removed from its deck by the "take-or-leave" attachment.



good construction and the load can be lifted up and removed from the truck as a unit.

In some instances it has been unnecessary to use a sheet of corrugated board underneath the load. The pusher attachment on the lift truck helps remove the product from the forks and is used to speed up the operation. The same truck can be utilized for unloading the boxcar.

Wherever possible, an attempt is made to alternate the car-unloading cycle from the truck-loading or unloading cycle so this truck can get double use.

The Kroger Company is responsible for the design of the four-wheel trailer with the separations on the top deck. They have had this system under test for the past 3 or 4 years. These separations make it possible to remove the loads from the trailer by allowing the multiple forks to go underneath the load; the lift truck lifts it off, proceeds inside the trailer, then the pusher attachment pushes off the load onto the truck bed Where a truck is loaded in this manner, it is possible to unload it the same way only if cardboard or sheets of paper are placed between each load since the cases will become entangled during transit.

Warehouse Handling. As merchandise comes into the warehouse, it can be set directly on the four-wheel trucks illustrated in Fig. 3 and taken to the storage point. It is removed from this truck either by means of the finger truck which places the load directly on the bed of the racks or on the floor directly underneath the first bed of the rack, or it can be taken with the same finger truck and placed directly upon a bulk-load pile. It is removed from this same pile and dropped to the ground for order picking by means of the turn-a-fork attachment on the lift truck. At this point the arms are turned upright and used as a clamp so that whatever number of cases are desired can be dropped directly to the floor in position for the order picker.

In some instances, ordering is being done in layer quantities, and the same lift truck removes cases from the bulk area in layers and places them upon the four-wheel truck. Here these layers are gathered together, taken to the shipping dock, and removed from the four-wheel truck with the finger truck and pushed directly onto the bed of the truck.

Summary

This completes the cycle of receiving, placing the goods in stock, and order picking. It is based on the premise that merchandise brought into a warehouse for turnover purposes is received in large quantities and removed in smaller units. It is designed to fulfill the problem of elimination of wasted effort required with handling a pallet. The use of the finger rack makes it easier for a man to pick his order. He doesn't have to climb onto the rack to reach the stock. He can use a hook to pull the cases forward on the finger, thereby always working from the front of the rack rather than from the back position as he now does.

The system developed here is a combination of compatible ideas that have been tried and proved in industry and put to work as a means of eliminating the back-breaking effort that is completely wasted. This back-breaking labor does not enhance the product, improve the quality, nor reduce the cost.

Abstracts and Comments Based on Current Periodicals and Events

D. FREIDAY
Assistant Editor

BRIEFING THE RECORD

Unified National Power System

ENGINEERS hear a great deal about the way in which power can help an underdeveloped country. Nicaragua, a country of 1.4 million people and approximately 52,000 sq miles is a good example of fitting a small power system to the country's needs.

An article by P. H. Jeryan, chief resident engineer, the Kuljian Corporation, in the February 15, 1960, issue of *Electric Light and Power* tells how this was done. The country formerly had one power plant of 10,160 kw with eight diesel engines "of varying vintage and states of repair" and a few scattered smaller units. It was given a relatively simple system that will reach 75 per cent of its population and help raise the economy of the country abreast of its neighbors.

The 200-mile-long strip averaging 20 to 30 miles wide between the country's two great fresh-water lakes—Lake Managua, 40 × 14 miles; and Lake Nicaragua, 100 × 40 miles—contains the four largest cities and approximately three fourths of the total population.

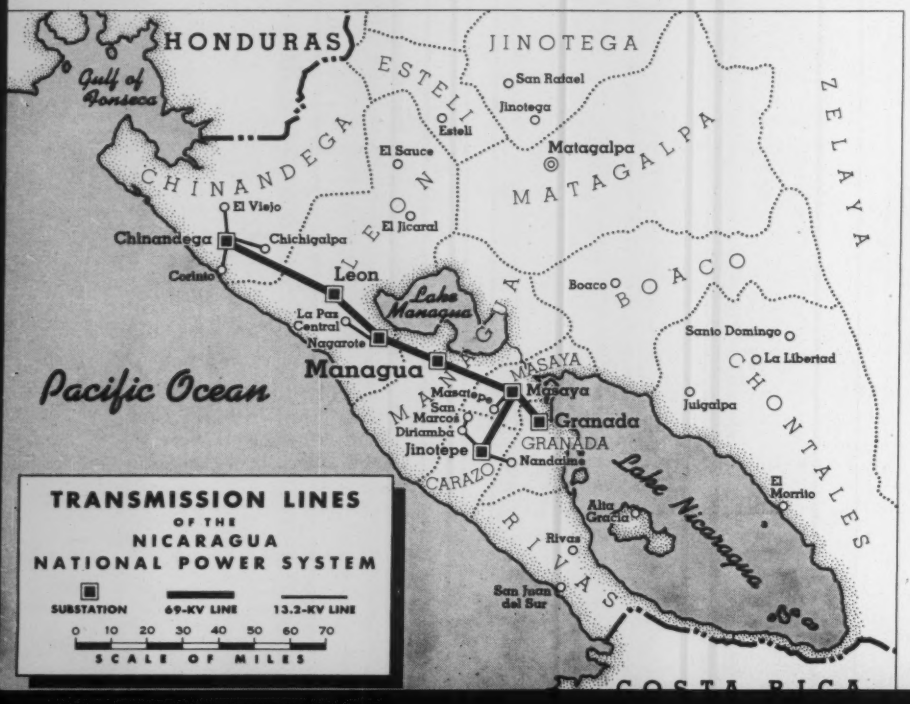
Loans for the entire project were secured from the International Bank for Reconstruction and Development (World Bank). The power plant, transmission lines with substations, and the Managua distribution system were built for Empresa Nacional de Luz y Fuerza. Power distribution work for the 14 towns in the project area was performed for the Instituto de Fomento Nacional. Both of these organizations are under government direction. Each town purchases its power from the Empresa and pays the Instituto in installments for construction of its distribution system.

In 1954 the Kuljian Corporation was engaged to study the country's needs and to make recommendations, and later was given the design, engineering, procurement, supervision of construction, and initial services for a power plant and expanded transmission and distribution systems—all on a turn-key contract.

A single network was designed that included a 33,000-kw steam power plant, 110 miles of 69-kv transmission lines, seven substations, 57 miles of 13.2-kv feeder lines, and new distribution systems for the capital city, Managua, and each of the other 14 towns served.

The power plant was located in the eastern part of Managua by the shore of Lake Managua, immediately west of the existing diesel plant. The location makes it possible to serve the northern and southern sections of the project area. The site also affords convenient interconnection facilities with a proposed hydroelectric power project under study for a location approximately 60 miles from Managua.

Location of the new thermal power station has the additional features of: (*a*) Proximity to the existing diesel plant, enabling its output to be co-ordinated with the new facility; (*b*) one management and operating force for both plants; (*c*) large areas available for future



A single network will serve three fourths of Nicaragua's population and help raise the economy abreast of neighboring countries. The population centers largely in the 200-mile-long, 20 to 30-mile-wide strip between the Pacific Ocean and the country's great fresh-water lakes. There are 110 miles of 69-kv transmission lines, seven substations, and 57 miles of feeder line. Map and illustrations courtesy of **Electric Light and Power** and the author.

Two 160,000-lb-per-hr semioutdoor boilers are employed in the 33,000-kw power plant, the first thermal installation in Nicaragua. Deaerating heaters are on the low roof behind the boilers. The plant has an unlimited fresh water supply from Lake Managua.

The modern plant supplies power to the capital city, Managua, and 14 other towns along the 110-mile transmission line. The site affords convenient interconnection facilities with a proposed hydroelectric power project 60 miles away.

expansion and oil storage tanks; (*d*) unlimited fresh water supply from Lake Managua; and (*e*) convenient railroad and highway facilities.

The 69-kv transmission lines use H-frame, flexible, hot-dipped galvanized-steel towers fabricated in Austria. The 13.2-kv lines use single wood poles, of American production, seasoned and treated to specifications.

Power in the new steam plant is generated at 13,200 volts, three phase, 60 cycles by two 16,500-kw turbine-generator units. These units feed a 13.2-kv bus to which output of the old diesel plant is also connected through three 3750-kva, 2400/13,200-volt transformers. This 13,200-volt supply, which also feeds the Managua distribution system through a four-wire grounded network, is stepped up to 69 kv through a 15,000-kva, three-phase, oil-immersed transformer, to feed substations outside Managua along the 110 miles of transmission lines.

Each of the two semioutdoor steam-generating units delivers 160,000 lb per hr of steam at a working pressure of 900 psig and total temperature of 910 F at the superheater outlet. The combustion control system is electrically operated. The boiler can be operated either by automatic or semiautomatic control. Remote manual controls are provided for the entire regulation system, permitting boiler operation by hand at any time.

Bunker-C fuel oil is used for combustion. This is delivered by tanker at the Port of Corinto, 70 miles north of Managua, and is transported by rail car or tank trucks to the two 600,000-gal storage tanks at the plant site. The oil is purchased in the foreign market.

Condenser circulating water is obtained from adjoining Lake Managua through four vertical mixed-flow pumps, two for each unit. Station service water is obtained from a deep well.

The first 16,500-kw unit started commercial operation in July, 1958, and the second similar unit went on the line in October of the same year. The 69-kv transmission lines and the 13.2-kv lines were placed in service in September, 1958; these are gradually being followed by connections of the distribution systems of the 14 towns outside Managua. The distribution system of the capital city began operation in April, 1959.

510,000-Kw Turbine-Generator

COMBUSTION ENGINEERING has been awarded a contract by Commonwealth Edison Company, Chicago, Ill., for a steam-generating unit to be built at Will County Station near Lemont, Ill. This unit will serve a 510,000-kw turbine-generator and will be the first unit of this capacity to be purchased by a privately owned utility company. Rising to the height of a 20-story building this giant will generate 3,900,000 lb per hr of steam (equivalent to evaporating more than 8000 gpm of water) at a pressure of 2500 psi and a temperature of 1000 F.

Known as a C-E Controlled Circulation Boiler, the unit will be of the radiant reheat, twin-furnace, pressure-fired type. At full capacity, it will consume $4^1/_2$ 50-ton carloads of coal per hr, which will be prepared for firing by eight Combustion Engineering bowl mills.

Since World War II Commonwealth Edison has purchased steam-generating capacity for six different power plants equivalent to nearly 2,500,000 kw from Combustion Engineering.

Sargent and Lundy are consulting engineers for the installation which is scheduled to start commercial operation in 1963.

Soot Blowers

A SOOT-BLOWER design for stationary and marine high-temperature boilers produced by the Blaw-Knox Company, Copes-Vulcan Division, Erie, Pa., has an estimated 250 per cent increase in service life and more complete soot removal because of the use of cast high alloy type HH (Alloy Casting Institute designation) heat-resistant alloy nozzle heads. These must resist unusually severe operating conditions, since boilers may be fired with black liquor, waste heat, pulverized coal, stoker coal, Bunker-C oil, or other fuel oils containing a high content of destructive sulfur, sodium, and vanadium pentoxide. Nozzle heads are exposed to flue-gas temperatures as high as 2300 F, radiant heat from burners, abrasive burner ash, plus the blowing medium—which may be air or saturated or superheated high-velocity steam at pressures from 100 to 600 psi and temperatures to 800 F.

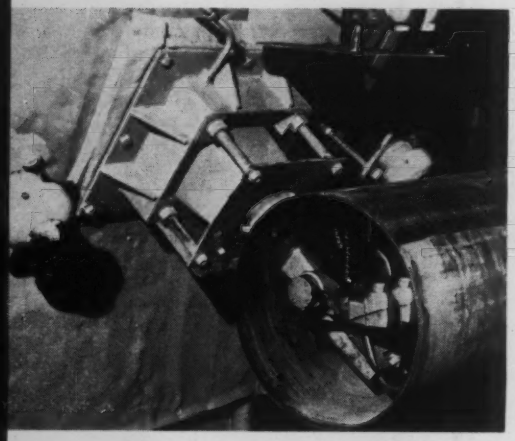
Severe thermal shock is also present since wet steam or cold air hits the hot nozzle when it first enters the furnace. Steep heat gradients result which cause accelerated fatigue failure in conventional materials of construction. ACI type HH, containing 25 per cent chromium and 12 per cent nickel, was selected for its resistance to cracking.

Continuous Weld Inspection

A CONTINUOUS fluoroscoping process which reveals any hidden flaws or defects in the welded seams of steel pipe has been developed by National Tube Division of United States Steel for further quality control and is being used on a production basis.

Formerly only the end portions of each pipe section were checked by x ray, with the continuous fluoroscoping process the entire weld is inspected quickly and efficiently. Flaws at any point show up sharply and are easily detected. The company states that there has been little change in the rejection rate, but the continuous fluoroscoping insures the maintenance of complete quality control.

The fluoroscope unit at National Works consists of an x-ray head mounted on a 48-ft boom, which fits inside the pipe in line with the welded seam and which casts a shadow image of a weld on the fluorescent screen of an



Continuous weld inspection is provided by a continuously fluoroscoping unit which travels inside a steel pipe. Image appears on a television screen inside an inspection booth.

image intensifier. The image is intensified electronically and picked up by a television camera. The televised picture, greatly enlarged, then is viewed by an inspector on a television monitor screen.

The inspector controls both the position of the 40-ft sections of pipe and their lateral movement. The carriage can be instantly slowed or stopped for prolonged examination of any portion of the weld. If a flaw is detected, the spot is marked by pressing a button which releases a spray of water-soluble white paint.

Vibratory-Finishing Equipment

A COMPLETE line of vibratory-finishing equipment which centers about an Air-Cushioned Vibratory Finishing Machine is now being produced by Pangborn Corporation, Hagerstown, Md. Representing 12 years of experimentation and refinement, the new line is distinguished by a suspension system long used successfully on buses and trucks.

Four rubber air cushions are mounted above the vibrating platform, and four are mounted below. Each series is pneumatically interconnected or manifolded and the air pressures are read at the operator's panel. Varying the pressure within the air-cushion system provides one means of regulating vibratory amplitude. Since no springs are used for suspension, metal fatigue and spring sag do not occur, and vibration at natural spring frequencies need not be avoided. The same air-cushion equipment is available in floor mounts when desired. In this case absence of floor vibration permits use of the Pangborn machines in buildings where structural limitations prohibit the use of conventionally floor-mounted machines.

Designed to replace and extend the application of tumbling and precision barrel finishing, the new machine embodies simple, rugged, and compact design features, with convenient and positive methods for controlling both frequency and amplitude of the vibratory work load.

The machine is adaptable to cleaning, descaling, deburring, radiusing (to exact blueprint specifications), fine polishing, coloring, and burnishing. The process is suitable for practically all ferrous and metals—castings, forgings, stampings, machined or pressed parts. In addition, many plastic and ceramic items may also be finished.

The Air-Cushioned Vibratory Finishing Machines come in $1^1/_2$, 3, 6, 12, and 18-cu-ft sizes, with larger models soon available. The new Pangborn line also includes accessories, auxiliary equipment, and a full range of media and compounds.

Ultrasonic Welding of Titanium

ACCORDING to a preliminary report by Aeroprojects Inc., West Chester, Pa., titanium is being ultrasonically welded. The welding technique permits the joining of high-strength, heat-treated titanium alloys with high joint efficiency and also permits the welding of titanium to other metals, something which has not been possible in the past. In addition, it may permit the use of lighter gage titanium on clad sections since there should be no problem in making clad joints.

According to an article in the *Titanium Review* published by Crucible Steel Company of America, the new metal-joining technique is a nonfusion, solid-state process for joining metals without the aid of solders, fluxes, or filler metals. A strong, metallurgically bonded lap-type junction is produced by clamping the workpieces at low static pressure between a welding tip and a suitable anvil, and delivering ultrasonic energy through the welding tip for a brief interval of time. The resulting weld shows neither the high external deformation associated with a pressure weld nor the cast-metal structure characteristic of resistance or other types of fusion welds.

Ultrasonic welds can be produced in a variety of joint geometries, including spot-type welds, annular or ring welds, seam welds produced by means of overlapping spots, truly continuous seam welds, and area welds. For a given weldment geometry, only the variables of power, clamping force, and weld pulse time (or welding rate, in the case of continuous-seam welding) need to be established. Once these settings have been adjusted, welding can then be carried out on a repetitive basis.

Although some temperature rise occurs in the weld metal during formation of an ultrasonic weld, the heating effect is extremely localized, does not approach the melting point of the metal, and hence does not result in a cast brittle structure. The 6Al-4V titanium alloy used in this investigation had a thickness of 0.008 in., while the B-120VCA alloy was 0.015 in. thick.

Magnetohydrodynamically generated power has been continuously produced from conventional fuel for 4 min. Operating at about one fourth of full-power rating, the generator has produced 2500 watts of power.

Magnetohydrodynamic Generator

THE first magnetohydrodynamic, MHD, generator of appreciable size to produce electric power "continuously" from the combustion of a conventional fuel has been demonstrated by Westinghouse.

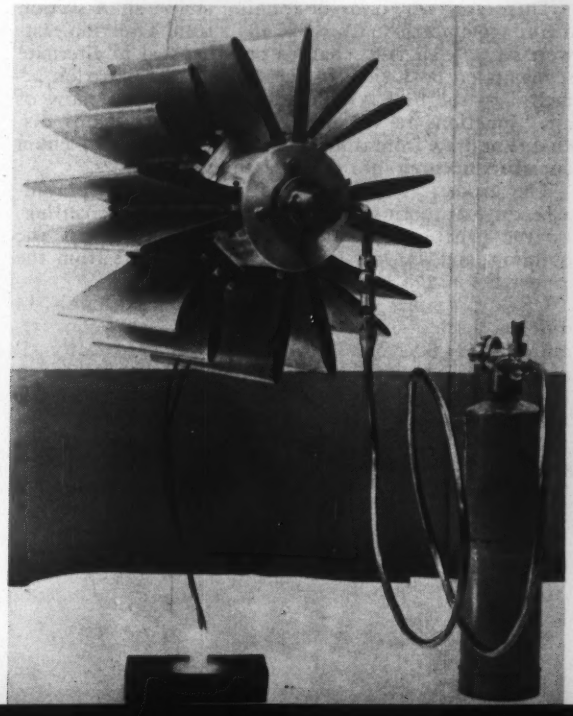
The MHD generator produces electric power by passing a superhot, electrically conducting gas—a plasma—between the poles of a powerful magnet (see MECHANICAL ENGINEERING, January, 1960, p. 52). This ionized gas, which substitutes for the copper wires in the rotating coils of a conventional electric generator, passes through a ceramic-lined tube at 1800 mph, cuts across the magnetic field, and produces electric power.

Operating at about one fourth its full-power rating, the generator has produced $2^1/_2$ kw of power and has run continuously for 4 min. Previously reported MHD generators have had operating cycles that were no longer than about 5 sec.

Experimental MHD generators have heretofore obtained their white-hot operating plasma from the heat of an electric arc, thus simply changing one form of electric energy into another. The Westinghouse generator, however, burns furnace oil with oxygen at a temperature of about 5000 F. Thus it accomplishes the kind of natural fuel-to-electricity conversion that is of prime concern for future development of the MHD generator as a large-scale source of power.

Demonstration of the MHD generator was part of a state-of-the-art report by J. A. Hutcheson, Mem. ASME, vice-president, engineering, of Westinghouse Electric Corporation, and company scientists, on methods of direct electric-power generation that included: (*a*) A high-temperature experimental fuel cell operating at over 1500 F and capable of converting a carbon fuel directly into electricity by electrochemical action; (*b*) a 100-watt thermoelectric generator capable of changing the heat of a gas flame directly into enough electric power to drive an electric bench grinder; (*c*) a thermionic generator capable of operating a small electric motor.

A commercial thermoelectric generator, with a 5-watt output—large enough for unattended navigational aids, radio communications, and scientific instrumentation in remote areas—is now on the market



Commercial Thermoelectric Generator

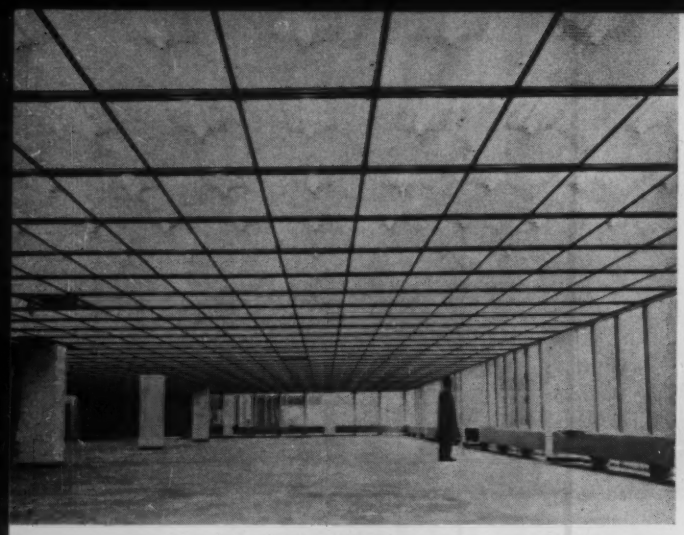
A SMALL thermoelectric power plant designed to produce 5 watts of electricity in unattended operation for radio communications, navigational aids, and scientific instrumentation in remote areas has been placed on the market by General Instrument Corporation, Thermoelectric Division, Newark, N. J. Only 1 ft high and weighing 10 lb, it has no moving parts and can produce electricity for a year on $10 worth (200 lb) of ordinary propane gas. It will keep running as long as the fuel supply lasts.

The price is expected to be $500 or less in large-scale production quantities. Single "evaluation samples" are available for purchase at a cost of approximately $5000.

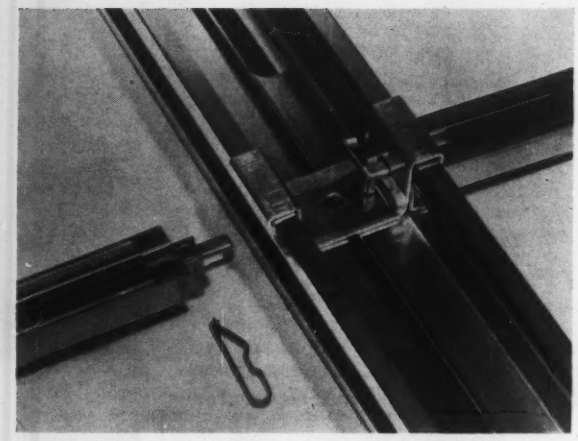
The device has a specially designed, "superefficient" burner that burns the propane gas at a constant temperature and uses more than 85 per cent of the heat content of the fuel.

Surrounding the outside of burner is a metal combustion chamber which captures the heat. Attached to each of the four sides of the combustion chamber are the "thermopiles"—semiconductor elements which convert the heat to electricity. The heat not used by the thermopiles is conducted directly to "heat-rejection fins" made of aluminum, which form the outer shell of the whole unit and give it a starlike appearance.

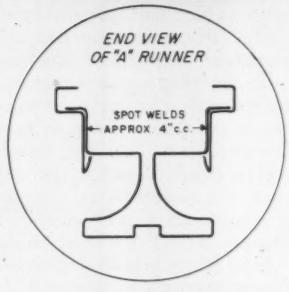
Five watts is the amount used to run the radio on the Pioneer V satellite, and also the output of the experimental SNAP III nuclear generator unveiled at the White House in January, 1959.



Standardized panels will line the entire ceiling area of the new Union Carbide Building. The ceiling system conceals the service equipment hung from the slab above, provides a source of illumination, distributes conditioned air, provides a top anchor for movable partitions, and blocks sound from traveling through the ceiling cavity. Office space can be rearranged overnight simply by shifting partitions.



Exploded view shows the assembly system used for the stainless-steel ceiling grid. T-runners are joined to A-runners with concealed spring-steel clips at 2-ft 6-in. intervals.



The A-runner is dual-ducted for discharge and exhaust of conditioned air in alternate segments on both sides of the A, so that attachment of partitions does not interfere with air flow

Modular Offices

ANY arrangement of offices can be made overnight in Union Carbide's new 52-story building under construction between Park and Madison Avenues and 47th and 48th Streets in New York City. The glass and stainless-steel curtain-wall uniformity of the exterior will be echoed in the interior where several major office-building problems have been solved by the use of $2^1/_2 \times 5$-ft standardized ceiling panels.

Each panel provides evenly diffused light, meticulously regulated air and heat, and an acoustic trap to prevent sound from jumping over partitions via the ceiling chamber. It consists of two basic parts—a fluorescent lighting fixture which provides a minimum of 50 desk-level foot candles of light with one third less electricity than "luminous ceiling" construction; and a stainless-steel framing strip which provides anchorage for a variety of forms of soundproof partitioning. In the north-south direction it also serves as a channel for alternate air-conditioning supply and exhaust vents to all areas except those within 15 ft of the outside of the building, where a perimeter system takes over.

With the unitized ceiling, offices can be literally rearranged overnight in any combination of $2^1/_2 \times 5$-ft modules merely by changing the partitions and moving the furniture. The channelized floor connections, long a standard feature of office design, permit phone, desk-lamp, and other connections to be rearranged. Since the air supply is also modularized to provide 76-F, 50 per cent relative humidity air in summer and 72-F, comfortable-humidity air in winter to all areas, no alteration of heating and ventilating systems is required. Over-all lighting also requires no changes.

The overhead glow provides a cheerful atmosphere; the plastic panels do not require costly painting or plastering, and yet they provide an attractive ceiling closure for the maze of conduits, wires, pipes, and other services hung from the bottom of the next floor. This ceiling-to-floor-above dimension is 3 ft 8 in.

The ceiling units are constructed of four main parts. The standard 40-watt fluorescent fixture is surrounded by a "bathtub"—a reflector designed to provide as uniform distribution of light as possible in order to avoid dark fringes. It actually achieves a marginal brilliance that is 80 per cent of the intensity directly below the fluorescent tube. Polyurethane gasket seals applied to all four edges act as dust traps, cushion for the diffuser, and an acoustical seal.

The plastic diffuser is a lamination consisting of two layers of 0.015-in. Bakelite rigid-vinyl sheet, plus a layer of 0.001-in. Krene cast-vinyl film on the side facing the light source. The cast-film layer provides a smooth, easily wiped surface that absorbs ultraviolet light which would be harmful to the rigid sheet.

There are two forms of framing strip—an A-section dual-ducted north-south strip, and a solid T-section east-west strip. Air is discharged or exhausted in alternate segments on both sides of the A so that a partition attached to the base will not interfere with the flow of air. Junctions in the supply and exhaust mains discharge or draw from thin rectangular sheet-metal plenum chambers opening into the A sections.

The acoustical deadening is completed by sprayed-asbestos fireproofing on the concrete above the ceiling, by the panel construction, carpeting throughout the building, and the low-level background noise from the air conditioning.

Union Carbide offices, now scattered through 14 different buildings in the Grand Central area have required $200,000 worth of alterations a year, nearly all of which will be saved by the modular system, and better lighting will be furnished for approximately $100,000 a year less than the cost of operating standard systems.

Mechanical and electrical consultants were Syska and Hennesy, Inc.; Weiskopf and Pickworth were structural consultants; Skidmore, Owings and Merril, architects; and George A. Fuller Company, contractor.

Stuck Drill-Stem Retriever

FISHING out stuck drill stems may not remain the time-consuming major operation it now is as a result of a hydraulic percussion jar developed by Southwest Research Institute for Bowen-Itco, Inc., and undergoing final testing at the company's plant in Houston, Tex.

Essentially, the new jar consists of a hammer, a case, and a valve. It is operated by energy of the mud column in the drill string. Maximum benefits from the tool will probably be realized by placing it in the drill-collar string, directly above the bit. When it is in this location, it will in no way interfere with normal drilling.

If the pipe, bit, or drill collars become stuck, the jar can be started by dropping the go-devil, or plug, into the pipe at the surface and pumping it down. When the plug lands on its seat in the jar, it will block circulation at the central control port. Since the fluid velocity is suddenly brought to zero, a water-hammer effect will occur, resulting in a pressure within the tool much greater than that being furnished by the pump at the surface. Since the area of the lower seal on the hammer is greater than the area of top seal, the pressure build-up causes the hammer to move rapidly upward.

When the hammer is a short distance from the anvil, the valve will be jerked off its seat by an inward-facing shoulder on the lower end of the hammer. The hammer will then strike the anvil. At this time, the valve spring has reached its fullest degree of compression and will immediately start raising the valve, allowing circulation to be resumed.

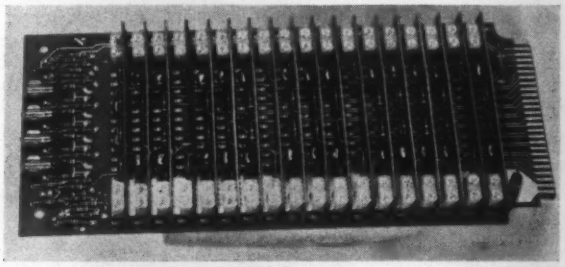
As the valve approaches its full-open position, the fluid velocity through the hammer increases, causing the pressure drop across the hammer to increase. The hammer rebounds off the anvil and the pressure drop acting on the area of the top seal serves to return the hammer.

As the valve approaches its seat, it will snap shut, stopping fluid flow and causing excess pressure. This action decelerates the hammer, reverses it, and starts a new cycle.

Once the pipe is free, free circulation can be re-established by going in with a wire line and overshot, latching onto the plug, and bringing it back to the surface.

Advantages of the jar over existing models include the following features: It can be mounted permanently and safely in the drill string; it can be started at any time and will jar upwardly at a fast and continuous rate; any strain desired may be maintained while the jar is operating; and jarring can be discontinued at any time by retrieving the plug from the jar.

Logic cards for the L & N 3000 transistorized digital process-control computer permit variations in programming



Industrial-Process Computer

A FULLY solid-state computer-control system has been developed jointly by Leeds & Northrup Company and Philco Corporation, both of Philadelphia. The L & N-3000 Transistorized Digital Computer is intended primarily for use in on-line data-reduction systems and process-control systems, but is also suitable for off-line uses.

The first system using the L & N 3000 Computer is scheduled to be installed late this summer at the Bergen Generating Station of the Public Service Electric and Gas Company of New Jersey. This system will be used to do performance calculations on two identical boiler turbine units and to provide operating guides. The system may be later expanded to perform closed-loop control functions.

Depending upon the particular on-line application, a system incorporating the L & N 3000 may perform: (*a*) On-line data reduction and calculation of operating guides, (*b*) program control, or (*c*) supervision computer control. Type (*a*) use could be for study of a particular process about which little may be known, or to permit open-loop control based upon performance criteria which would be impossible with manual calculation. Program control could be used for process startup or shutdown with or without operator control. In supervisory control it would calculate and set the optimum reference levels for local analog control loop.

Reliability and fail-safe performance were important design considerations. The L & N 3000, is a general-purpose, serial, internal-binary, fixed-point, stored-program computer with the following characteristics: (*a*) Address structure—single address or 1 + 1 as determined by the programmer; (*b*) order structure—16 basic orders, including square root, which may be modified to provide over 60 operations; (*c*) computing times—add or subtract, 0.91 milliseconds; multiply, divide, or square root, 3.6 milliseconds; shift, 0.91–3.6 milliseconds; (*d*) data—word length of 20 bits + sign + parity; storage—main memory, magnetic drum, 8000 or 16,000 words; rapid access, 4 words standard; arithmetic registers, three transistorized registers including the accumulator, two of which may be used as additional rapid-access storage.

The L & N 3000 computer is intended primarily for use in on-line data-reduction systems and process control

Versatile Vertical Machine

United Air Lines is revolutionizing jet-engine overhaul with a new type of vertical machine capable of a variety of grinding, boring, facing, turning, and associated operations. It represents industry's answer to the demands of jet-age travel for the equivalent of "longer runways" in the maintenance shop.

Big enough to handle such large parts as turbine-engine diffuser cases, the Heald 578 vertical can accommodate work up to 52 in. in diam and 48 in. high. It is versatile enough for grinding tips of rotor blades; turning ID's and shoulders of aluminum rings in stator blades; turning and grinding stainless-steel diffuser-case joints; grinding bearing seats on shafts and in rotor-shaft bores; toolroom jobs such as grinding the planimeter rings for checking the shape of sheet-metal sound suppressors, the holding fixtures used on the machine, and the tips of bushings in a ring jig for locating 80 ventilation holes inside the diffuser casing.

United is the first airline using this type of machine for the rebuild jobs on jets which differ from piston-engine overhaul.

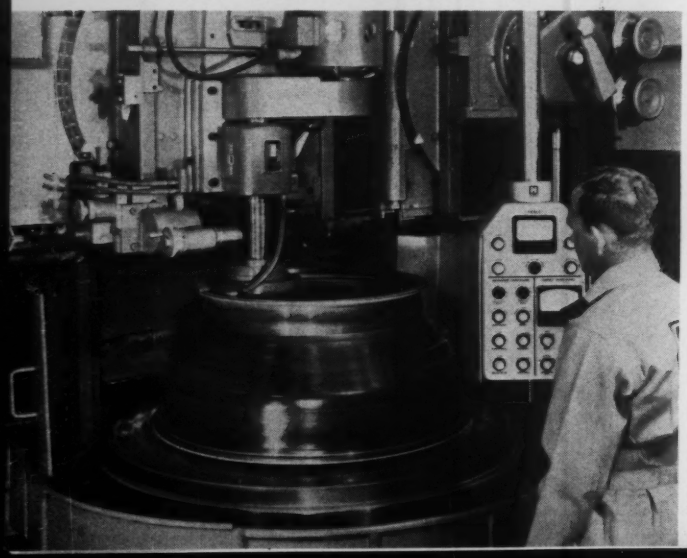
Jet parts require a big machine (the 578 is 15 ft wide and 12 ft deep) with great swing and travel and rigidity to handle big components but with a light touch for smaller aircraft parts. Flexibility for machining several types of metal on the same equipment demands greater versatility in speeds, feeds, and controls.

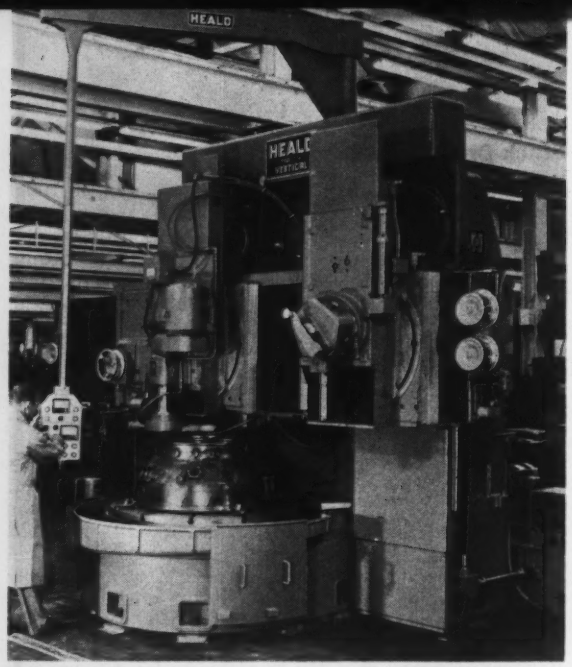
The alternate method of rebuild might be using a vertical grinder or gap-type internal grinder plus a lathe—both with horizontal spindles. Because the work must rotate, mechanical problems are encountered in mounting big parts on a horizontal machine. The 578 for example can use a 40-in-diam roller thrust bearing under the work table which would be impractical in a horizontal machine.

When the Pratt & Whitney engines which power the DC-8 Jet Mainliners enter the turbine overhaul and test section at United's 128-acre base they are stripped to individual components for preliminary cleaning. Such big parts as the diffuser cases are suspended on an overhead-conveyer system for the hours-long trip through various solvents. After inspection, the stainless-steel cases move to the Heald vertical for boring and turning operations.

Chrome-plating levels the worn and pitted areas, after which finish grinding (at up to 6000 surface fpm) restores the part to dimension within a required tolerance of 0.0003-in. and 15-rms finish.

A big stainless-steel turbine diffuser case is ground on the Heald model 578 vertical machine by remote control from the pendant





The Heald vertical machine is capable of a variety of grinding, boring, facing, turning, and associated operations

Diffuser cases are held with four chuck jaws on the table. Rotor and stator rings are clamped on the table with hold-down clamps between sheets of $^1/_4$-in-thick rubber centered on a steel stud to prevent distortion during grinding. Carbide tools are held in the turret by ram-type holders, and Cimcool coolant is used, circulating at 20-gpm at 30 psi.

Electrohydraulic Turbine Control

An electrohydraulic control system 10 times faster and four times more sensitive than present mechanical controls has been announced for General Electric's medium-capacity steam-turbine generators.

Regarded as a major step toward power-systems automation, the first applications will be on industrial units for power and process steam.

The system consists of a tachometer generator, pressure transducer, and a solid-state analog computer which directs hydraulic valve-positioning devices to satisfy both load and extraction-flow demands.

The turbine start-up and operating controls are located on the computer console. The computer automatically signals the switch control room when the turbine is ready to be synchronized with the load. The centralization of controls facilitates start-up and makes it easier for the operator to put the unit into service.

The computer has high reliability with solid-state electrical components designed for both long life and application flexibility. There are no vacuum tubes to maintain or replace. The computer is preadjusted and ready for easy installation.

A fire-resistant, hydraulic fluid is used for long life and safety.

The first installation is now in service on a 12,500-kw single automatic-extraction condensing unit with 600-psig inlet pressure and 200-psig extraction pressure.

The electrohydraulic control system is the third major development announced this year for medium-capacity steam-turbine generators, the others being a new hydrogen-gas control system and a new static-excitation system.

Clinch River Power Plant

A THIRD 225,000-kw generating unit will be added to the Clinch River Plant at Carbo, Va., currently believed to be the world's most efficient steam-electric power producer. The plant began operation in October, 1958, and is owned and operated by Appalachian Power Company, an American Electric Power Company operating subsidiary which serves portions of a four-state region—Virginia, West Virginia, Kentucky, and Tennessee. It is situated in the middle of an extensive field of economically mined coal supplied by the Clinchfield Coal Company under a long-term contract and delivered directly to the plant via a short rail haul.

The expansion, to be completed in late 1961, will cost approximately $28 million and will raise to over $85 million the total investment in the three-unit power plant which will then have a total capacity of 675,000 kw.

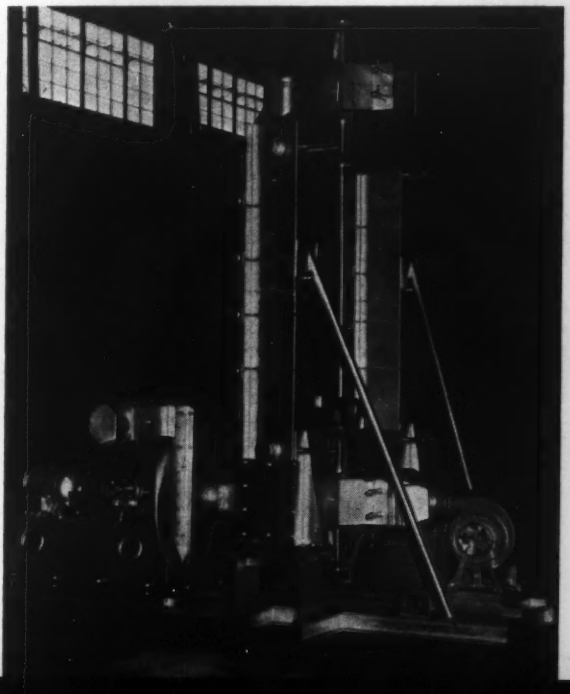
Portable Heat Exchangers

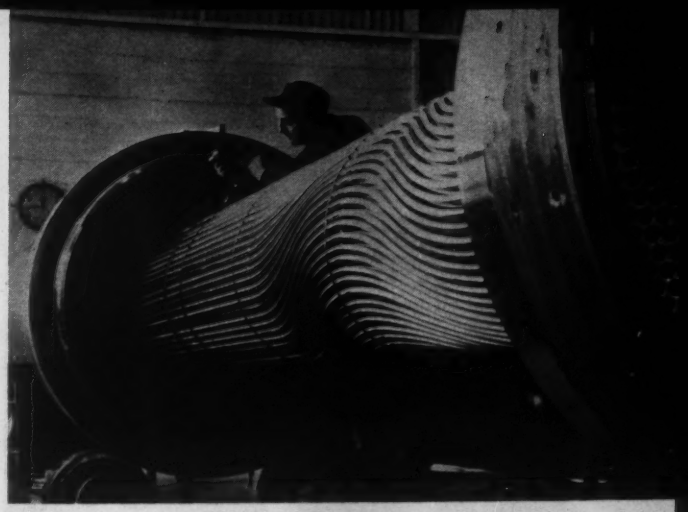
Two high-temperature experimental test heaters—designed to evaluate proposed applications of equipment to new processes—have been developed by the Air Preheater Corporation, Wellesville, N. Y.

Completely portable and easily installed, the experimental testers simulate the regenerative cycle of the Company's Ljungstrom air preheater and are being used to determine what the performance of the preheater would be when applied to fuel-burning equipment where the particular characteristics of the flue gases that are being used are unknown.

One is now in operation on a chrome-roasting process, and is being installed for testing on a black-liquor furnace.

Completely portable, easily installed high-temperature test heaters have been designed to evaluate proposed new process applications





A unique sine curve in the Type 304 stainless-steel tubes of the sodium heat exchangers for the Enrico Fermi Atomic Power Plant will accommodate differences in thermal expansion

A timer mechanism operates dampers which cause alternating flow of the air and gas streams. The maximum gas-inlet temperature of the test heat exchangers is 1500 F.

Enrico Fermi Heat Exchangers

MORE than 19 miles of Allegheny Ludlum stainless-steel tubing will be used in three intermediate sodium heat exchangers being built by Alco Products, Inc., Dunkirk, N. Y., for the Enrico Fermi Atomic Power Plant near Detroit, Mich.

The 88-in-diam, 31-ft-long units are the largest sodium heat exchangers to be built to date, and each weighs 130,000 lb. Cost of the three exchangers has been estimated at about $1,750,000.

One of their unique features is a special sine curve which Alco puts into the Type 304 stainless-steel tubes to accommodate differences in thermal expansion. Each tube—approximately 18 ft long, with an OD of $^{7}/_{8}$ in. and an 18-gage min wall thickness—is bent cold on a machine that has been especially designed by Alco for this purpose.

The tube bundle can also be easily removed from its shell to facilitate maintenance, whereas most exchanger units in nuclear application are of all-welded, integral construction, and must be cut apart for repair. In addition to being removable, the bundles have a gasketed joint which separates the primary from secondary sodium fluids.

Ten-inch-long springs act as the load members for setting and sealing this joint.

Each of the three Alco heat exchangers is designed to transfer 489 million Btu per hr at flow rates of 12,500 gpm. Primary sodium coolant flows by gravity from the reactor at a temperature of 900 F through the shell side of the unit to the pump from which it is returned to the reactor at 600 F. Secondary sodium from the steam generator is pumped at 520 F through the downcomer in the exchanger, and through the 1860 bowed tubes where it is heated to 820 F by the primary sodium. It then returns to the steam generator.

Three primary coolant loops and three secondary coolant loops will be connected to one reactor in the Fermi plant which is scheduled for start-up late in 1960.

A miniature refrigeration unit developed for cooling infrared cells. Like many electronic components, these show improved performance in the cryogenic temperature range.

Expansion-Engine Refrigerator

By allowing work to be done in a reciprocating-piston engine, gas is cooled to the cryogenic range in a new refrigeration process developed by Arthur D. Little, Inc., of Cambridge, Mass.

The process is described in a paper by William E. Gifford and Howard O. McMahon, "A New Refrigeration Process," presented at the 10th International Congress of Refrigeration, held last summer in Copenhagen, Denmark.

The gas engine is more efficient than vapor-cycle cascades and is useful below 78 K (−319.7 F), a range where these cannot be employed. One of the most striking advantages of this refrigerator is that it can be miniaturized and still achieve temperatures as low as 55 K (−360.7 F) in a single stage.

A unit developed for cooling infrared cells has a cylinder which is only 0.22 in. in diam and 2 in. long. A regenerator is incorporated within the piston, and the valves, crosshead, and motor drive are in the body. The gas flow required is only 0.2 to 0.3 standard cfm between pressures of 50 and 250 psia. The time needed to reach 80 K (−345.7 F) from room temperature is only about three minutes. The net useful refrigeration is small, since most of it is used to overcome heat leaks through the steep temperature gradient because of the short cylinder length.

Much use is expected for these devices in the new field of refrigerated electronic components. There are many new electronic devices that show improved performance if refrigerated to a very low temperature. Heat loads associated with these devices are usually very small. This process offers a means for achieving these temperatures in a simple, reliable, relatively trouble-free piece of equipment.

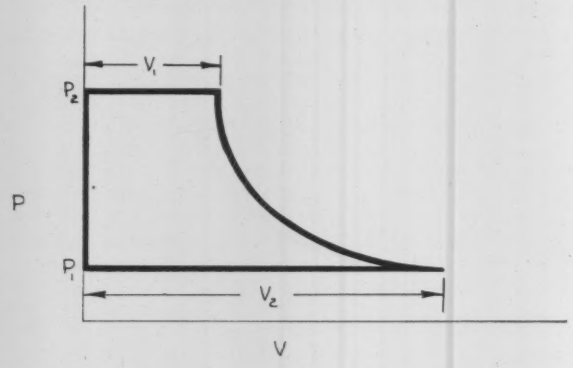
An added practical advantage is that water vapor and/or oil vapors in the gas supply do not prevent operation even in a small refrigerator cooling to 60 K (−351.7 F). The vapor is condensed by cooling on its way through the regenerator and re-evaporated on its way out.

The functional system consists of a piston and cylinder with crankarm for removing work done on the piston. The piston gas seal is at room temperature. Gas is supplied from a compressor through a mechanically controlled inlet valve at room temperature. The high-pressure gas then passes through the regenerator to the expansion space formed by the displacement of the piston. Gas is exhausted back to the suction of the compressor again through the regenerator and leaves through the mechanically controlled exhaust valve.

The piston is loosely fitting (0.005 to 0.010-in. clearance on a side) in the cylinder, except to a tight-fitting seal at the warm end. Warm-end operation permits the use of lubricants. To prevent heat leak into the cold region, the cylinder is made of thin-wall stainless steel and the piston of a hollow plastic such as micarta.

The regenerator is simply a small thin-wall stainless-steel cylinder packed with several hundred 100 to 200-mesh punched wire screens made to fit snugly into the cylinder.

The miniature expansion-engine refrigerator produces cold gas which may be used as a refrigerating fluid to cool small electronic components for more efficient operation. The operating cycle consists of: (a) Pressure buildup—the inlet valve is opened with the piston at the extreme end of the cylinder, building pressure from P_1 to P_2 in the regenerator; (b) intake stroke—with the inlet valve open, raising the piston to a volume V_1 draws a charge of gas into the expansion space; while passing in through the regenerator the gas is cooled as it heats the matrix material of the regenerator; (c) expansion stroke—the inlet valve is then closed, and the pressure drops due to further movement of the piston. Although it is theoretically more efficient thermodynamically to raise the piston until pressure has fallen to P_1, it may be more practical to expand only part way and allow further expansion when the exhaust valve is opened; (d) exhaust stroke—the exhaust valve is opened and lowering the piston forces the expanded gas through the exhaust valve; on the way to the valve the gas is heated back to room temperature, cooling the matrix material of the regenerator. It thus stores refrigeration to cool the next charge of gas.



Welding Cast Iron

A simple three-step process for arc welding cast iron in as little as one tenth the time required by conventional methods has been revealed by Eutectic Welding Alloys Corporation, Flushing, N. Y. The process is based on a new electrode which provides deposits that can be quenched without danger of cracking to eliminate time-consuming slow cooling between welding passes. Preheating is also eliminated, peening is not required in most cases, and there are no toxic fumes.

The QuenchWeld process is equally suitable for thin sections or heavy castings and will allow repairs not now attempted because of the distortion and cracking that result from high welding temperatures. Applications include repair of cracked or broken castings, filling of blowholes and machining errors, buildup of worn or broken gear teeth or other damaged surfaces, joining

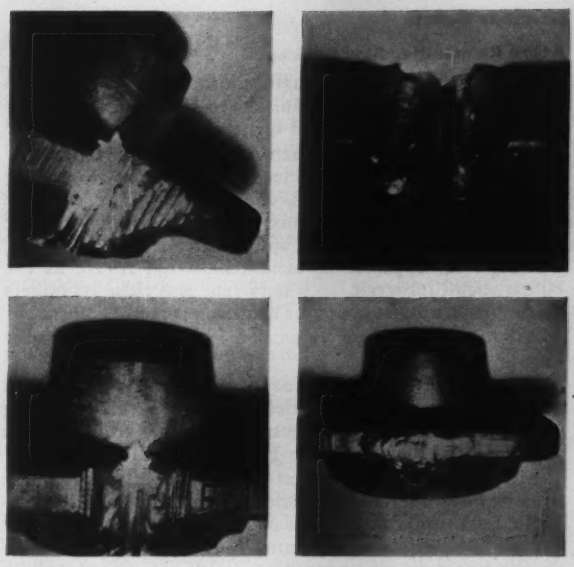
cast iron to cast iron, and joining cast iron and steel. The process permits rapid, permanent, in-place repair of such castings as machine-tool and press bases, columns, and pedestals; motor blocks; gear and pump housings; motor frames; gears; and pipe.

The three steps are aimed at the three basic reasons why cast-iron welds crack: Stress concentration, contamination of the weld, and stresses due to cooling exceeding the strength of the weld metal.

The first step utilizes a chamfering electrode called ChamferTrode to V out the area to be welded, and to make grooves to break up stress concentration around the V. The second is filling of the antistress grooves, and coating the entire weld area with a thin deposit, using EutecTrode 27 sealing electrode. This prepares the surface for a strong bond between the cast iron and the final deposits. It seals the surface so that grease, chemicals, and other contaminants which are often a bar to successful cast-iron repair welding cannot affect the soundness of the final weld metal. The third step is to complete the weld with a special new electrode.

The QuenchTrode 24 electrode eliminates slow cooling between passes and can be quenched immediately with water. It provides a deposit low in carbon, alloyed with grain-refining elements, is machinable, and has the toughness to resist accelerated cooling without cracking. QuenchTrode 24 is an all-position, a-c or d-c, electrode available in diameters of $^{3}/_{32}$, $^{1}/_{8}$, $^{5}/_{32}$, and $^{3}/_{16}$ in.

Using QuenchTrode 24, the third step is completed by back-step welding, with beads of 1 to 4 in. depending on section thickness. Elimination of the wait for cooling enables deposits to be built up in minutes which formerly would have required hours.



Basic steps in cast-iron welding with the QuenchWeld process: Upper left, V has been cut with a chamfering electrode where casting was cracked; **upper right,** chamfering electrode has been used to make antistress grooves; **lower left,** grooves have been filled and entire V thinly coated with sealing electrode; **lower right,** the finished weld, ready for machining, has been built up with passes of QuenchTrode 24

Plastic Fume Scrubber

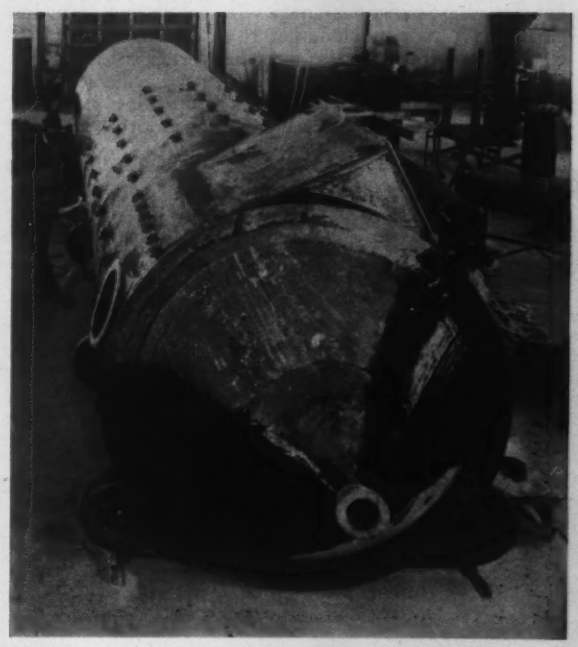
A HUGE fume scrubber, over 47 ft high and 10 ft in diam fabricated from reinforced plastic, is a major part of a fan, ventilating, and dust-control installation designed and engineered by Buffalo Forge Air Cleaning Division, Buffalo, N. Y. The giant apparatus for use in metallurgical processing handles effectively 42,000 cfm of dust-laden gases. Both construction and size are unique. The only metal used is in supports and external fasteners and it is reported to be the largest industrial unit fabricated from reinforced plastic. To handle the large volume of severely corrosive fumes, mists, and dusts of fluoride compounds, Buffalo Forge selected a fiberglass-reinforced polyester plastic—Hetron 92—a product of the Durez Plastics Division of Hooker Chemical Corporation.

Selection of this chemical and fire-resistant plastic was based upon a number of considerations: Light weight, $^{1}/_{7}$ to $^{1}/_{10}$ that of a steel unit of comparable size, without sacrificing structural strength; flame resistance, chemically inherent in Hetron, without lowering physical properties; corrosion resistance; and virtual elimination of maintenance.

Du Verre, Inc., of Arcade, N. Y., fabricated the main shell of the hydraulic scrubber to Buffalo Forge design specifications. A second unit 24 ft high by 5 ft in diam is being built to control magnesium oxide and fluoride compounds at a rate of 10,000 cfm. The two units will be served by 100 ft of fiberglass-reinforced Hetron 92 ductwork supplied by du Verre. A third "baby unit" of 20-in diam is also under construction.

Due to shipping limitations, the large unit is being transported to its destination with exterior piping disassembled. Upon arrival, the equipment will be erected and almost 150 individual spray nozzles will be connected under the direction of Buffalo Forge engineers.

A huge 42,000-cfm fume scrubber for use in metallurgical processing has been fabricated from fiberglass-reinforced plastic. It weighs only $^{1}/_{7}$ to $^{1}/_{10}$ as much as a comparable steel unit yet is structurally strong, chemical, and fire-resistant.



Nuclear Briefs

▶New Remote-Handling Devices

Two new mechanical manipulators for remote handling of radioactive materials have been introduced by the Mechanical Division of General Mills.

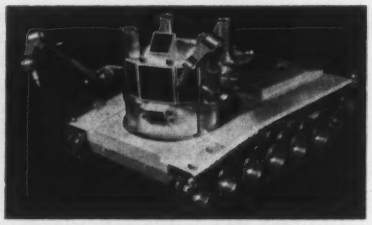
The Model 550 has an arm stretch of approximately 18 ft outward from a shoulder boom, and can hold more than 100 lb at arm's length. It has eight separate motions, each of which can be made at infinitely variable speeds. It can both flex and rotate at the shoulder, telescope its upper arm, bend its elbow, rotate at the elbow, bend its wrist, spin its wrist, and close its fingers with either a light touch or crushing force.

All movements are controlled from a small portable box.

Two of the Model 550 mechanical arms will be used as a pair on a large beetlelike mobile vehicle being constructed by General Electric Company, for service at the National Reactor Testing Station, Idaho.

Model 150 is the smallest of the General Mills line which now includes six motor-driven, remotely controlled manipulators, and was designed especially for use where both alpha and gamma radiation are present, as in the processing of plutonium. It is compact enough to be mounted inside a small, airtight enclosure placed within a conventional "hot cell," or it can be mounted on an overhead bridge, a boom, vehicle, or post.

It is the first mechanical arm to have a 360-deg shoulder swing and will shortly be placed in service at Los Alamos Scientific Laboratory.



Mechanical arms for handling radioactive materials will be operated from the heavily shielded cab of a tanklike vehicle. Cab and arms will also elevate on telescoping columns.

▶ 5-Oz Geiger Counter

A 5-oz transistor Geiger counter called the Gelman-Wallac-Sparrow has been put on the market by the Gelman Instrument Company of Chelsea, Mich. The unique Sparrow gives instantaneous radiation warning to atomic workers and researchers.

Within a split second after existence of radiation danger, the Sparrow signals workers to evacuate immediately. Not much larger than a king-size pack of cigarettes, the device slips into the worker's shirt pocket where it is always on guard. When radiation reaches 1 milliroentgen per hr, the speaker crackles violently. The tone of the speaker changes to a smooth buzz at 10 milliroentgen per hr and then to a high-pitched whine at 100 milliroentgen per hr.

It operates on a set of small flashlight batteries which last for 2 to 3 weeks of normal usage and cost only a few cents a month to operate. No expensive wiring or other materials are needed. The batteries are the only maintenance cost.

Within a split second after the appearance of radiation danger, a Geiger counter small enough and light enough to be worn in a workman's shirt pocket sounds an alarm—a violent crackle at 1 milliroentgen per hr, a smooth buzz at 10, and a high-pitched whine at 100

▶ Franklin Institute to Study Gas-Cooled Reactor

The Franklin Institute has been awarded a $72,000 research contract by the Atomic Energy Commission to study problems related to nuclear reactors that use gas as a coolant and operate at temperatures up to 2500 F.

Operating conditions of high-temperature, gas-cooled reactors, and the design and materials for reactor equipment that can withstand these conditions will be studied. An extended survey will be made of all commercial equipment that could be utilized in gas-cooled reactors and fabrication, inspection, erection, and maintenance problems of other reactor equipment will be weighed.

▶ Nuclear-Superheat Unit in Puerto Rico

The Atomic Energy Commission has signed a contract with General Nuclear Engineering Corporation of Dunedin, Fla., for final design of the nuclear portion of a demonstration 16,300-ekw boiling-water UO_2-fueled reactor. The $11-million unit to be built in co-operation with the Puerto Rican Water Resources Authority in Puerto Rico and will produce nuclear-superheated steam within the core.

The Authority will provide the site and the conventional turbogenerating facilities, operate and maintain the reactor on a reimbursable basis, and purchase steam from the AEC.

In addition to providing the final design, General Nuclear Engineering Corporation will perform research and development related to core calculations, fuel-assemblies performance, moisture removal from steam, fuel-unloading techniques, and cooling of superheater fuel elements.

The reactor scheduled for completion in late 1962 is expected to advance the Commission's nuclear-superheat program.

▶ PM-1, Portable, Medium-Power Nuclear Plant

Final design of the PM-1 (Portable, Medium Power) nuclear power plant, for the Air Force station in Sundance, Wyo., has been completed by The Martin Company, Baltimore, Md. The plant will supply 1000 ekw for radar equipment and provide 7-million-Btu-per-hr heat for Air Force buildings. The plant is being built under AEC contract in 16 air-transportable prepackaged units which can be joined together readily during the seasonally short construction period at some remote military bases. A single fuel loading for PM-1 will be sufficient for two years of operation.

▶ Nuclear Windows Withstand 30g

Large-sized nuclear windows made by Ray Proof Corporation, Stamford, Conn., have withstood shock forces in excess of 30g without damage to the glass or window mounting at a U. S. Navy test laboratory.

The windows were designed and manufactured for the *USS Long Beach*, under Bethlehem Steel Company subcontract.

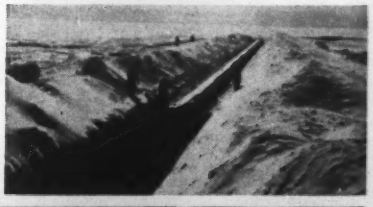
▶ PM-2A Skid-Mounted Nuclear Power

The PM–2A, a portable medium-power, pressurized-water, skid-mounted nuclear reactor, has been tested at the thermal-products division plant of Alco Products, Inc., at Dunkirk, N. Y. The reactor will be installed later this year at Camp Century, Greenland, which will be manned by about 100 engineers and scientists for research studies on the icecap. Built under a $3.2-million contract for the Army Engineers, the plant will deliver about 1560 ekw net and about 1 million Btu of steam for heating.

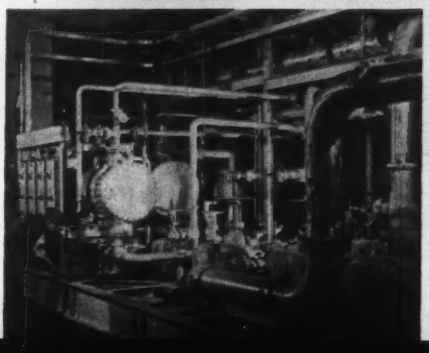
Ten skids hold all station generating equipment from the reactor vessel to the turbine generator, switch-gear, and the control console. The plant breaks down into 27 air-transportable packages which meet the size and weight requirements of C-130 military cargo aircraft. Maximum weight of a single skid is 15 tons and the largest is 28 ft × 9 ft × 8 ft 7 in. A trained crew of about 31 Army personnel can install the plant in Greenland in about six weeks. The plant will be operated by men trained at the prototype SM–1, the Army Package Power Reactor, Fort Belvoir, Va., which has produced more than 25 million ekwhr on its first core.

PM–2A incorporates two major advances over the SM–1 and the SM–1A currently under construction at Fort Greely, Alaska. Total plant weight has been reduced from 2500 to 300 tons, and test and assembly time has been cut from 18 to 3 months.

Because of the frigid locale the condenser-cooling system will use air and ethylene-glycol in place of water. Fuel elements are similar to those in the SM–1, but the core size has been reduced by removing eight corner elements without reducing the 10-tmw output. Control-rod drive mechanisms were taken from the SM–1 design. An optimization study determined the best combination of components. A tube-side pressure of 1750 psia was selected, and a shell-side pressure of 465 psig at full load provides a plant with good operating efficiency, low weight, and conservative operating procedures. Throttle steam temperatures and pressures for the turbine-generator are 450 psig 459 F.



Housing for the PM-2A reactor will be provided by special plows. These dig a broad trench to create a tunnel covered with corrugated steel before the snow is pushed over the top.



The PM-2A reactor system is divided up into 10 skid-mounted sections which will be connected together and installed in rows in the tunnels

Materials Briefs

▶ Paper Records Disappearing and Reappearing Messages

An electrostatic recording paper made by Alfax Paper and Engineering Company, Westboro, Mass., records simply by passing a low-voltage, low-current signal through the paper. Up to 18 tone shades can be obtained and recorded at speeds up to 100 ips. They can then be made to disappear entirely and return within 30 min without further processing. A letter, order, or blueprint can be scanned for transmission by wire and recorded at a distant point so that no one operating the recorder can read the message.

▶ Columbium-Containing Steels

Great Lakes Steel Corporation, Detroit, Mich., a division of National Steel Corporation, will produce and market a new family of columbium-containing steels. According to the company they will be the highest strength weldable steels ever developed for pipeline application in the natural-gas industry. Other potential uses are for truck frames, highway lighting posts, railroad equipment, and pressure vessels.

One of the fastest growing segments of the national economy over the past decade, the natural-gas gathering, transmission, and distribution industry uses more than 4 million tons of steel annually. It has earmarked $12.6 billion for 1959–1970 transmission pipe construction.

The GLX-W steels are weldable during subzero temperatures, without need for any prewelding preparation or special welding techniques. The potential reduction in cost for this season is $500 per mile, and under normal-weather conditions by $224 to $316 per mile.

Also involved for field installation of conventional high-strength steel pipe is special training for welders and special type welding rods.

GLX-W steels are available in guaranteed minimum yield strengths of 45,000; 50,000; 55,000; and 60,000 psi. Their ability to be bent and formed to follow the path of pipeline ditches is comparable to that of the high-strength steels now in use.

A GLX-W (45,000-psi) grade has already been fabricated into 5 miles of 24-in. diam pipe which has been in service since September, 1959, without incident.

▶ Plastic Production-Die Models

The wooden die models used by auto manufacturers can be replaced by a new plastic paste and models made directly from full-sized clay styling models.

A plaster or plastic female mold is taken from the clay in sections convenient to separate. These female molds are repositioned around an armature (or stacking cube) which is positioned on a surface plate relative to established body lines. REN Shape, RP-301, the plastic-paste material made by Ren Plastics, Inc., of Lansing, Mich., is then applied approximately 1 to 2 in. thick into the female surface, and webbing or fiberglass tubing is positioned between this new surface and the armature. The female molds are removed, leaving a relatively finished male reproduction of the styling clay.

One half of the model is then splined to the exact surface specified by the styling and engineering departments, whereupon two sets of templates are removed. One set is delivered to Engineering so that interior structure can be designed, while the other is used to reproduce the approved surface, producing a perfectly symmetrical, dimensionally stable master model.

PHOTO BRIEFS

M. BARRANGON

1

1 Telescope Mirror. He's inspecting the optical surface of the biggest fused-silicon mirror ever made, the primary reflective piece in a 36-in. telescope to be carried aloft by an unmanned balloon for outer-space photography. Corning Glass made the blank: The finishing was done by Perkin-Elmer Corporation of Norwalk, Conn. Fused silica has a near-zero thermal expansion. This is for Project Stratoscope II, in which photo equipment will be carried to 80,000 ft.

2 Bayonet Heater. Believed to be the world's largest tantalum bayonet heater, this big heat exchanger was made by The Pfaudler Company, a division of Pfaudler Permutit, Inc. Tantalum is fully resistant to all acids except hydrofluoric. It makes possible thin walls—in this case 0.015 in. "Vacuum purge" welding was used because of tantalum's affinity for oxygen, nitrogen, and hydrogen.

3 Cargo Tires. These "tire tanks," made by Goodyear, have completed their Army "physical." The U. S. Army Transportation Materiel Command purchased the rolling liquid-transporter units—two tires to a unit—from Goodyear's Aviation Division. The "Rolli-Tankers," which are 64 in. high and 42 in. wide, carry 500 gal of liquid and can be towed by any vehicle because of their high flotation and mobility.

4 Mixer. Close the 16-in. barrel (by a hydraulic mechanism) without the mixing screw, and this big food mixer looks like a naval gun. Chemical Machinery Division of Baker Perkins, Inc., Saginaw, Mich., built the 21-ton machine for a newly researched food product. The mixing screw rotates close to the teeth of the barrel, teeth and flights being machined to tolerances of 0.005 in. or less. Stainless steel, of course. Ten thousand lb of material per hr.

5 Preheater. At the Bayway, N. J., refinery of Esso Standard, Division of Humble Oil & Refining Company, they are lowering a 1000-lb element into the rotor of a regenerative counterflow preheater manufactured by Air Preheater Corporation. The equipment is for a new furnace in Esso's largest fluid catalyst cracking unit. The Ljungstrom preheater will recover heat from the furnace's exit gases.

6 Aluminum Mandrel. This started out as the world's largest aluminum hand forging (by Alcoa's Cleveland Works). After machining, at Douglas Aircraft, it was plated with nickel. The entire assembly was then exposed to subzero temperatures, causing the aluminum mandrel to separate from its nickel coating. Result: A perfectly formed nickel shell for use as a liner for the Mach 6 (4500 mph) nozzle in industry's first major hypersonic wind tunnel.

7 Cobalt 60. The scene: A hot well, privately owned by the Budd Company in North Philadelphia, Pa. A cobalt 60 pellet, held by tweezers, is being incapsulated by the remote control of a master-slave manipulator operated by an instrument division technician. He is looking through a 2-ft-thick glass-and-oil window. The cobalt 60 will be used for irradiation ("hotrodders"), or radiography (detection of flaws in welds and castings) or for cancer therapy.

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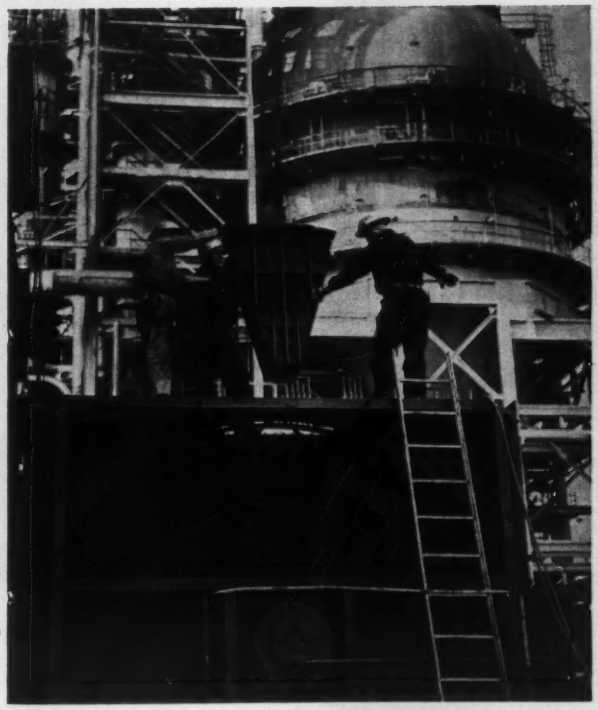

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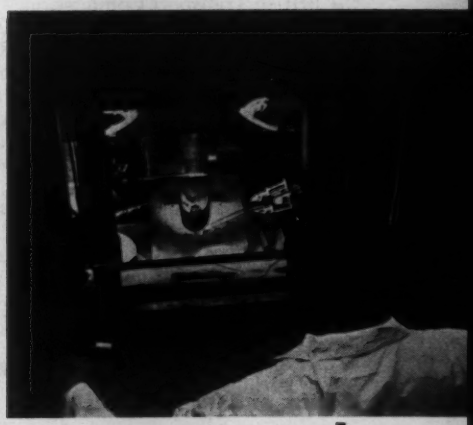

7

Engineering Progress in the British Isles and Western Europe

J. FOSTER PETREE
European Correspondent

EUROPEAN SURVEY

Here is the last steam locomotive to be built by British Railways

Last Steam Locomotive

On March 18 the last steam locomotive built by British Railways left the Swindon Locomotive Works in Whiltshire, England. In a ceremony attended by a large number of distinguished locomotive engineers it was named "Evening Star" by K. W. C. Grand, a member of the British Transport Commission.

The engine is one of the Class 9 2–10–0 heavy freight locomotives designed by British Railways and is the 999th of their standard range, introduced after the railway systems of the country were nationalized. It weighs 139 tons 4 cwt in working order, with the tender, and has a tractive effort of 39,667 lb. The two cylinders are 20 in. diam and 28 in. stroke, and the coupled wheels are 5 ft diam. The length over-all, including tender, is 66 ft 2 in. The heating surface (with superheater) is 2550 sq ft, the grate area 40.2 sq ft, and the boiler pressure 250 psi. A rocking grate is fitted and is so arranged that the right-hand and left-hand sides can be rocked independently. The tender carries seven tons of coal and 5000 gal of water.

Boring and Milling Machine

The Italian machine-tool firm of Azeta SRL, Via Locatelli 6, Milan, has brought out a new boring and drilling machine, the GL-80, designed for general engineering production at high efficiency. The spindle is 80 mm ($3^1/_8$ in.) diam and has a feed stroke of $25^1/_2$ in. (650 mm). Sixteen speeds are provided over a range of either 16 to 1330 or 11 to 890 rpm. The revolving table, which can be supplied either $31^1/_2$ in. by $39^1/_2$ in. or $35^1/_2$ in. by 47 in., is driven by a separate $2^1/_2$-hp motor and can be locked at the four 90-deg positions. The heavy-duty vertical milling head can operate on horizontal or inclined surfaces. The surfacing head, which can work over 30 in. diam, has eight automatic feed settings, independent of the spindle speed. The distance between the spindle center and the table is variable between $1^1/_2$ in. and 30 in. or, at option, 36 in. Full control by push button is provided by the swinging pendant, but two hand controls are also available for the cross traverses, for setting purposes. End microswitches are fitted for all movements. Feeds can also be controlled by a hand lever, while running, if desired. The screw-cutting mechanism is designed to cut a wide range of Whitworth, metric, and other threads. Lubrication is by Bosch pumps, of which there are four, supplying, respectively, the spindle, the feed gearbox, the longitudinal and cross ways, and the revolving table.

Berkeley Nuclear Power Station

The 275-mw nuclear power station under construction at Berkeley, on the River Severn, England, is one of the first atomic stations to be designed solely for commercial purposes. Commissioned by the Central Electricity Generating Board, it is situated on the eastern bank of the river, about 26 miles from the city of Bristol, and its two reactors will provide energy for about 332 mw. Thus there will be a useful margin over the guaranteed net output to the national grid of 275 mw.

Work started on the 96-acre site in January, 1957. One of the first jobs was to raise the level of most of it by 10 ft to avoid flooding from the river. At the same time the extensive excavation for the two reactors was undertaken. Some 200,000 cu yd of material have been excavated and about 132,000 cu yd of concrete placed. Most of the civil engineering work is now completed; the mechanical engineering is about three-quarters complete; and the chief undertaking now in hand is the installation of the reactors and their associated equipment. It is expected that No. 1 reactor will be active in rather less than a year from now and No. 2 reactor about six months later. The main contractors are the AEI-John Thompson Group of Companies.

Each of the reactor pressure vessels is 80 ft high, 50 ft diam, and weighs 1000 tons. These dome-ended cylinders are welded up from 3-in-thick steel, increased to 4 in. at the connections to the gas ducts. Each will con-

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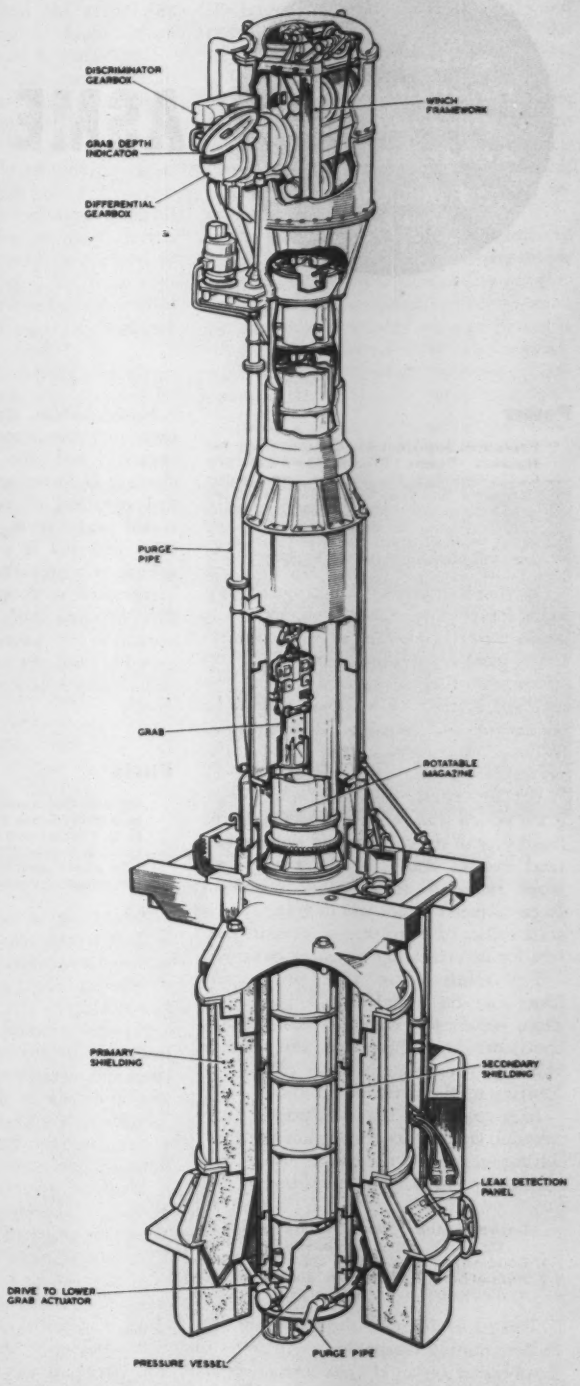
tain 2000 tons of graphite. In this graphite core there are 3275 fuel channels, each containing 13 fuel rods of natural uranium in magnesium alloy casings, helically finned. The total weight of uranium in each reactor will be 250 tons. The cooling gas which transfers the heat of reaction to the heat exchangers is CO_2.

To detect any contamination of this gas by leakage from a burst fuel can, 3275 steel sampling tubes are passed into the pressure vessel, the end of each tube located near the outlet of a fuel channel. Every 30 min the CO_2 is automatically sampled and tested in a burst slug detector. Any irradiation is signaled to a central computer system which evaluates it and, if the contamination level is too high, sounds an audible alarm. The detector valve will indicate which channel is at fault, and the defective fuel element can then be removed and replaced by a fresh one.

The apparatus for charging and removing the fuel elements is a new design developed to meet requirements of the United Kingdom Atomic Energy Authority by the John Thompson Ordnance Company, a member of the John Thompson Group. It comprises five parts or sections, namely, the chute machine, about 50 ft high, which places 40-ft long chutes to act as guides between the charge floor and the nuclear pile; the visual observation and removal equipment which, using closed-circuit television and remote-controlled grabs, enables portions of a broken fuel element to be recovered and stowed in a 20-channel magazine for later disposal; the charge-discharge machine; the flux-scanning winch, which lowers a tungsten wire into the nuclear pile, where it absorbs radiation at a rate depending upon the condition of the surrounding fuel elements, thus providing data for the programming of fuel exchange; and the control rod and actuator serving machine which, by means of remotely operated grabs, can pick up and move the control rod and its supporting cable in three planes so as to separate or reconnect them.

The precision with which these machines operate is remarkable, considering their size and since they are remotely controlled. The charge chutes, for instance, which select the fuel channel to be recharged, out of a possible 3000, are located at a distance of 40 ft within 0.22 in.

Radioactive contamination can be found as gas courses through this detector at Berkeley Nuclear Power Station



Part of the apparatus for charging and removing the fuel elements is this 50-ft-high chute machine, of new design, at Berkeley Nuclear Power Station which holds three 40-ft chutes in a magazine to act as guides between the charge floor and the nuclear pile and can place any of them over any one of 3000 fuel channels as a guide for insert-fuel charges

Substance in Brief of Papers Presented at ASME Meetings

ELEANOR RAMP
Edit. Asst.

ASME TECHNICAL DIGEST

Power

Pressure Suppression Containment for Nuclear Power Plants..59—A-215... By C. C. Whelchel, Pacific Gas and Electric Company, San Francisco, Calif., and C. H. Robbins, Assoc. Mem. ASME, General Electric Company, San Jose, Calif. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

Pressure-suppression containment provides for venting into a water pool the steam-water mixture that would be released from a water-moderated reactor in the very unlikely event of a break in the primary system. The steam would be condensed and most of the entrained fission products would be retained in the pool.

This paper describes a development program which was performed to determine feasibility of the concept and how a practical system could be designed. Test work included direct condensation of large-diameter steam jets in water, and a scale model of a pressure-suppression system for investigating transient behavior.

Test results show that large steam flows can be completely condensed in small volumes of water, system pressure transients can be predicted, and that the water pool can be extremely effective in limiting release of fission products.

It is concluded that the pressure-suppression concept has important potential advantages over the more usual dry-capsule type of reactor containment.

Decentralized Peak-Shaving..59—A-283 ... By C. W. Bary, Philadelphia Electric Company, Philadelphia, Pa. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

This paper discusses the procedure used in determining the possible economies to be obtained on an electric utility system through the establishment of an expansion policy for power-production facilities wherein a certain amount of decentralized peak-shaving capacity is periodically installed.

Many factors are considered in determining the amount of peak-shaving capacity and the possible effects of changes in future conditions. A simplified equation of cost savings under a stated peak-shaving policy is presented. Also included is a theoretical analysis which indicates the portion of savings attributable to the peak-shaving function as contrasted with that attributable to reduction in average reserve margins possible with the use of the smaller size units under a decentralized peak-shaving policy.

Fuels

Oil-Ash Corrosion of Superheater Alloys in a Pilot-Scale Furnace..59—A-281... By N. D. Phillips and C. L. Wagoner, The Babcock & Wilcox Company, Alliance, Ohio. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1., 1960).

Benefits to be gained from the use of higher steam temperatures in oil-fired boilers have warranted a laboratory investigation of oil-ash corrosion of superheater alloys.

In order to investigate oil-ash corrosion under conditions where the gas temperatures and metal temperatures are different, and to determine methods of alleviating corrosion, a research program was instigated at the Research Center of the authors' company.

Metal temperatures of 1100–1300 F with flue-gas temperatures of 1350–2500 F were investigated, using steam-cooled tubular specimens in a small boiler fired with natural gas and diesel oil containing various combinations of vanadium, sodium, and sulfur.

A pilot-scale furnace was constructed for testing alloys under closely controlled conditions of gas temperature, metal temperature, fuel composition, and firing conditions. Provisions were made for the use of additives as one possible method for reducing corrosion.

Tests performed to study the effect of fuel-oil composition and metal and gas temperature on corrosion are presented. Results show that AISI Type 310 alloy has better corrosion resistance than do Types 304, 316, and 321.

Data are presented on the effectiveness of additives in reducing the severity of metal corrosion. Additive materials fed as a dry powder produced sufficient reduction in corrosion so that alloys at 1200 F metal temperatures with additive suffered less corrosion than they did at 1100 F without additive.

Aviation

Hydraulic Servo Transmissions for Target Tracking Radar Drives..59—A-329... By T. E. Beal, Sperry Rand Corporation, Detroit, Mich. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

Tracking today's high-velocity ballistic-type targets with constant speed, rotating radar antennas, similar to those used in World War II, would be very impracticable since those targets were comparatively slow-moving propeller-driven aircraft.

Today's targets are moving at thousands of miles per hour and must be located, tracked, and destroyed within a very brief span of time. Radar tracking is an important part of this defensive mission; the system must be highly sensitive, responsive, and automatic far beyond the limits of human sight, sound, and reaction time.

The experience gained from hydraulic servo-operated gun turrets in aircraft and naval ships proved the advantages of this type of power transmission. The ease of control, fast response, and large power output from a small package made hydraulic servo transmissions a natural choice for driving radar tracking antennas.

The paper discusses the requirements

for such drives and discusses in some detail a typical 10-hp unit and its performance characteristics. This packaged unit has many possible military and industrial applications where high response and dependability with instantaneous control of position and velocity are required.

Among the performance characteristics of hydraulic servo transmission for target tracking radar drives are high efficiency, high power, low inertia of rotating parts of output motor, wide range of output speeds, constant torque available at all output speeds, low excitation or input signal power, fast response, no backlash between output motor and load, reliability, and easy maintenance.

Rotative Power for Large Antennas..59—A-268...By P. A. Crosby, Assoc. Mem. ASME, and D. A. Regillo, Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Mass. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

The trend toward larger search radar antennas has increased the need for more accurate estimates of the dynamic loads on these structures. Previously, large factors of safety could be used in designing the structure or the drive system without increasing their cost significantly. However, with large antennas, the cost of the structure and of the drive system can be reduced if the dynamic loads can be estimated accurately.

This paper describes a method of calculating the power to rotate a large search antenna in a wind of constant velocity.

The actual power requirements of a large search antenna are compared with the calculated power to rotate the antenna through a complete revolution while the wind speed is constant, and with the maximum calculated power for different wind speeds.

Close agreement between the actual and theoretical power indicates the technique for determining the power that can be used with other similar antennas.

Improved Air-Induction Systems Through the Use of Interaction..59—A-269...By M. L. Morris, Curtiss-Wright Corporation, Quehanna, Pa. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

The author explains the design, function, and efficiency aspects of air-induction systems for turbojet-powered aircraft. It is shown that proper air-induction-system design initiates at the point where the free stream is first acted upon by the flow field produced by the aircraft body. The influence of the body flow field upon the air from this point to the inlet affects not only inlet design but engine and aircraft performance.

To realize fully the potential of this concept of design, and the techniques developed, much higher flight Mach numbers than 2.0 should be considered.

Considerable work has been done to develop air-induction systems that demonstrate high-pressure recovery and desirable mass-flow characteristics, the author concludes. By employing variable geometry, internal-bleed systems, and optimized boundary-layer-removal systems, total-pressure recovery of the order of 85 per cent may be realized at inlet Mach numbers of 3.5. It is suggested that by using procedures described in this paper, inlet designs of simplified geometry may be obtained.

By employing the inherent shock system of the prime vehicle supplemented by environmental control, the operational range of a developed air-induction system may be extended by as much as one unit of Mach number, and with results that are superior to a complex system designed for the extended Mach number.

Design of the FPS-35 Antenna..59—A-267 ...By C. W. Souder, Sperry Gyroscope Company, Great Neck, N. Y. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

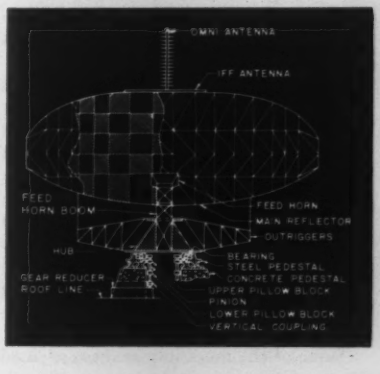
The FPS-35 is a search radar containing all the refinements now known to be available for use in such an equipment. It is being designed and built under the technical guidance of the Rome Air Development Center of the United States Air Force.

The antenna for the FPS-35 is probably the largest of its type in this country and possibly the world. A complete description of the assembly is given.

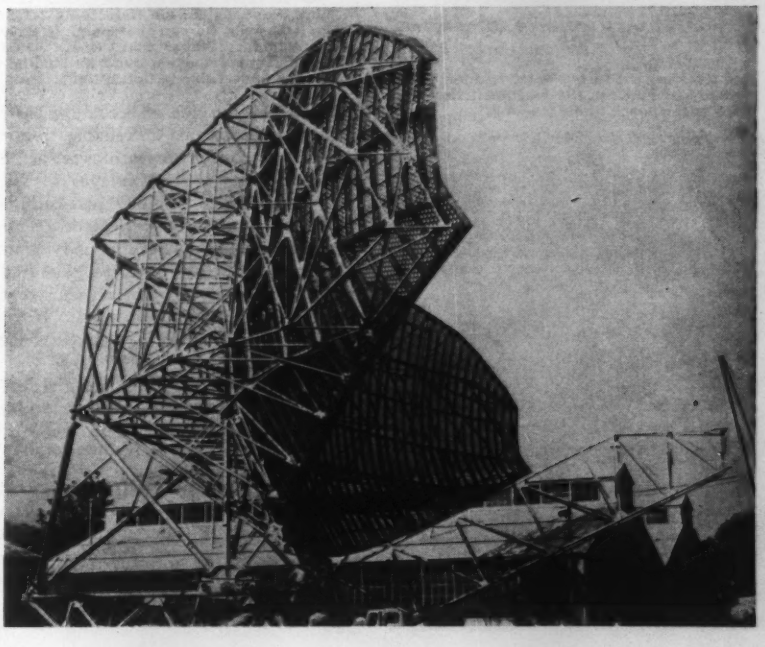
The design life criterion is ten years of essentially continuous operation. The approach to this requirement has been to use components capable of lasting throughout the entire operational period, rather than attempting to program replacement.

The antenna reflector is approximately 125 ft × 40 ft and constitutes the major part of the 140,000 lb of rotating weight. Drive power is supplied by wound-rotor a-c motor, and reduced voltage power is supplied by wound-rotor a-c motors, with reduced voltage starting. Construction is of steel to keep cost low.

Simplified cross-section sketch of the reflector equipment for the FPS-35 ground-based search radar (59—A-267)



The FPS-35 antenna erected at the fabricator's plant prior to shipment to site (59—A-267)



The FPS-35 antenna was designed, manufactured, and the first piece erected in 18 months.

Mechanical Design of 150-Ft-Diam Metal Space Frame Radome..59—A-271... By T. F. King, Mem. ASME, and L. P. Farnsworth, Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Mass. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

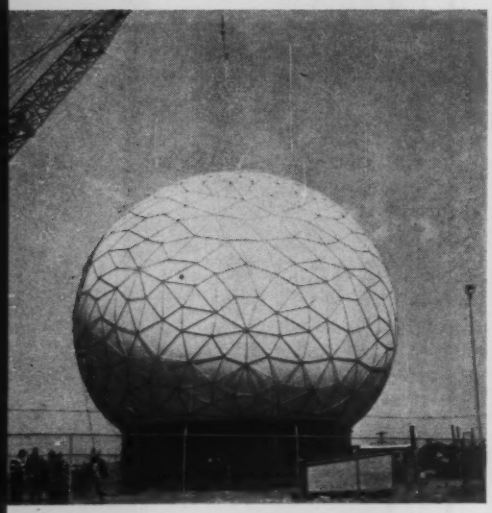
This paper discusses a brief history of the development of rigid radomes leading to the design of a 150-ft equatorial diameter metal space-frame radome. This radome is the most recent structure to evolve from the rigid radome development program started at M.I.T. Lincoln Laboratory in 1953. As radome sizes increased, the number of Fiberglas panels of which they were made increased, as did the width and depth of their flanges. These flanges formed essentially a Fiberglas space frame and presented some electromagnetic blockage to radar antennas when installed within the radome.

The purpose of the metal space-frame radome is, by reducing the size of the flanged edges and maximizing their efficiency, to minimize electromagnetic blockage and scatter through efficient mechanical design.

Mechanical design considerations to insure structural and electromagnetic integrity including the space frame, end fittings, the hub, capstrip and spring material, and neoprene seals are described.

Some of the more important tests used to confirm analytical results are presented.

One-third size model of the 150-ft radome constructed to evaluate the electrical characteristics of the space frame (59—A-271)



Criteria for Design of Foundations for Precision Tracking Radars Considering Dynamic Response..59—A-328... By C. Fu and J. W. Jepson, Bell Laboratories, Inc., Whippany, N. J. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1959).

In order to maintain the required accuracy of a precision tracking radar, the servo motor which drives the antenna should be referenced to an infinitely rigid foundation. For a reinforced-concrete foundation mounted in and upon soil, this condition is not satisfied. However, by a suitable choice of parameters of the foundation, the excursion of the mount due to resonance between the servo system and its foundation can be made negligible in one of two ways.

The impedance of the foundation in the frequency band of the servo system may be made sufficiently large, or its natural frequency can be increased to a value much larger than that of the servo system. Inertia and spring constants were obtained from equations based on a lumped-parameter system.

Equations were solved by means of Laplace transform with numerical computation being performed on a IBM 704 digital computer. Optimum design curves were then plotted from these results. Two foundations have been designed and built utilizing results obtained from this analysis and testing of the foundations to verify the analytical results will commence in the near future.

Gas Turbine Power

The Combined Steam Turbine-Gas Turbine Plant for Marine Use..59—A-237... By R. G. Mills, Bureau of Ships, U. S. Navy Department, Washington, D. C. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

As the gas turbine is becoming more widely accepted as a reliable prime mover, numerous investigations are being conducted into the advantages of the combined steam-turbine gas-turbine (COSAG) type of power plant. This power plant has basic thermodynamic characteristics which give it a potential for high efficiency which surpasses that of either of its component cycles. It has promise of marked savings in space and weight.

In summation, the combined steam-turbine gas-turbine cycle offers important advantages for marine use in three respects:

1 For destroyer, frigate, and escort types, the parallel COSAG plant is a simple means of effecting significant savings in size and weight of the machinery plant, and modest savings in fuel rate at all cruising speeds.

2 The COSAG plant with an unfired steam generator allows extension of the excellent efficiencies comparable to those of very large marine steam plants into the middle and lower power ranges, making the turbine plant competitive efficiency-wise with the large marine diesel in the freighter, tanker, and comparable ship types.

3 The COSAG plant with a pressure-fired steam generator will allow considerable weight and space savings, as compared to the normal steam plant, for very high-powered ships.

Development and Sea Trials of Marine Proteus Engines for Brave Class Fast Patrol Boats..59—A-273... By B. G. Markham, Bristol Siddeley Engines, Ltd., Filton, Bristol, England. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

This paper deals with the adaptation and development of the Proteus aircraft gas turbine which has been undertaken on behalf of the British Admiralty for fitting to the Brave Class fast patrol boats.

These aircraft engines are used in the Bristol Britannia airliner. It is shown that the Proteus engine shows a substantial reduction in specific fuel consumption compared with the early naval gas turbines. It also weighs less.

Experiments are described of shore testing under simulated marine conditions such as the assessment of the effect of sea water entering the engine air intake. It was found that ceramic coatings on turbine stators could provide protection from salt corrosion. Safety devices, air intake, and the exhaust system are described.

Comparison of diesel and gas-turbine characteristics is given, as are results of sea trials.

Textiles

Use of Textile Machines as Research Tools..59—A-220... By J. F. Bogdan, North Carolina State College, Raleigh, N. C. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

The role of textile processing machines as scientific instruments in fiber development programs is explained. The author states that the desirable attribute of a textile fiber is its ease of conversion into yarn and fabric. The paper is concerned with the task of the textile development laboratory to observe, to measure, to evaluate processing behavior of fibers, and to recommend changes for their improvement.

Processing small samples, the drawing process, roving, physical testing, dyeing, and weaving are considered.

Typical examples of standard check lists used in making detailed observations

of performances made during the processing of a sample of fiber are included.

Aviation—Reliability

Gas-Turbine Reliability Control Procedures..59—A-219... By R. R. Brown, Department of the Navy, Washington, D. C. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

Reliability of repeated-used systems, such as engine of manned aircraft, requires consideration of seriousness and probability of occurrence as well as number of malfunctions. This paper describes the development of a procedure for analyzing those malfunctions in order of seriousness of result.

It is the belief of the author that reliability can be achieved by asking the following questions about each part of an engine or subsystem:

1 What can this part do wrong?

2 What will be the effect of each malfunction?

3 What is the best way to reduce the seriousness of the effect of the malfunction?

4 What is the probability of occurrence of those class I malfunctions which cannot be avoided?

An engine designed according to this procedure may not have any smaller number of total malfunctions, but the malfunctions will be less serious. In addition, the critical parts, those resulting in class I failures, will be pinpointed for special attention during manufacture, maintenance, and future design development so that the engine will successfully complete a greater number of its planned missions.

Developing Reliability in the T58 Engine Control..59—A-291... By R. H. Rosenberg, General Electric Company, SAED, Lynn, Mass. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

After a brief engine and control description and a statement of the initial considerations of reliability, the step-by-step program to develop reliability in the T58 engine control is outlined.

Resultant changes are discussed, program costs compared to savings, and the present degree of reliability defined.

The author states that the T58 gas-turbine engine system was conceived and developed just prior to the time when formal reliability procedures and commitments became the rule in the aircraft gas-turbine industry. It has been developed into a machine of better than 1000-hr reliability by the application of sound engineering judgment with little mathematical guidance.

A review of the program shows that careful initial design, continued endurance testing, and constant emphasis on feedback of failure information have contributed heavily to the excellent record in service.

Jet-Engine Trend Analysis..59—A-297... By P. J. Bruneau, Department of the Navy, Washington, D. C. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

A review of the removal reports on turbojet engines in the Navy system consistently shows that only approximately 25 per cent of the jet engines processed through the overhaul and repair activities are overhauled because of reaching the prescribed time between overhauls. This staggering preponderance of premature engine removals is mainly due to the failure or malfunction of some engine part or component.

Recording and analysis of certain significant indices of engine performance can predict engine malfunctions and incipient component failures. Problems of reliable recording, inaccurate or inadequate instrumentation and ground-test equipment, determination of the index significant to each individual engine type must be solved.

Hydraulics

The Turbulent Boundary Layer at a Plane of Symmetry in a Three-Dimensional Flow..59—A-72... By James P. Johnston, Ingersoll-Rand Company, Phillipsburg, N. J. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

Methods for treating a turbulent three-dimensional boundary layer at a plane of symmetry are presented. Reasonable agreement with experiment was achieved by the use of momentum integral techniques in the prediction of momentum thickness, shape factor, wall shear stress, and the location of separation.

The case of flow containing a plane of symmetry has been treated. Methods of solution involving the use of the momentum integral equation along the plane of symmetry together with auxiliary expressions and methods for treating the velocity profile, shape factor, and skin friction have been presented. It has been shown, for a particular case, that these methods yield results in good agreement with experiment.

It is the author's hope that methods similar to that shown for reducing the momentum integral equation from a partial to a simple total differential equation may aid in solution of other plane of symmetry problems. Also, it is felt, although not fully justified, that the use of two-dimensional auxiliary methods for determining the shape factor and skin friction will lead to good boundary-layer solutions.

Laminar Boundary Layers in Oscillatory Flow..59—A-265... By P. G. Hill and A. H. Stenning, Massachusetts Institute of Technology, Cambridge, Mass. 1959 ASME Annual Meeting paper (multilithographed; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

A number of important fluid-dynamic phenomena, including stall flutter and rotating stall, are governed by boundary-layer unsteadiness and are not, therefore, well understood.

The problem of finding the behavior of the boundary layer in the presence of an unsteady pressure field is, in general, still unsolved though solutions are available for special cases.

This paper describes an experimental and analytical study of a laminar boundary layer subjected to a pressure gradient which was the sum of a steady adverse component and a small oscillating component corresponding to small x-independent oscillations of the free-stream velocity.

Experimentally, adverse pressure gradients were produced to develop mean boundary-layer profiles of the Howarth type. Detailed measurements of oscillations were made for the two conditions of Blasius flow and a Howarth flow fairly near separation.

It was found that there are three types of behavior, corresponding to low, intermediate, and high frequencies. Low and very high frequency oscillations are shown to be well described by existing approximate solutions.

However, an intermediate frequency region required a new analytic treatment, the results of which do account for the measured flow behavior in that region.

Incidence and Deviation-Angle Correlations for Compressor Cascades..59—A-171... By Seymour Lieblein, Lewis Research Laboratory, NASA, Cleveland, Ohio. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

An analysis is presented for the variation of low-speed, minimum-loss, incidence angle, and deviation angle for compressor-cascade blades. The aerodynamics governing the behavior of these angles is discussed, and the principal influencing parameters are established.

A single general relation is obtained for predicting these angles for conventional sections such as the British C-series blades, the double circular-arc blade, and the NACA 65-series blades when the latter blade sections are ex-

pressed in terms of an equivalent circular-arc chamber line. The specific constants associated with each blade shape are derived from the available data.

The Adiabatic Bulk Modulus of Normal Paraffin Hydrocarbons From Hexane to Hexadecane..59—A-169... By R. E. Rolling and C. J. Vogt, Mem. ASME, University of California, Berkeley, Calif. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

The current investigation was motivated by problems associated with fuel-injection systems in internal-combustion engines in which a minute volume of fuel is measured and injected into the combustion chamber at a predetermined time. The design and operation of these systems depends upon the properties of the fuel used, particularly the bulk modulus, viscosity, and the specific gravity at the temperatures and pressures expected to exist within the fluid volume.

A method for determining the sonic velocity in a fluid as a function of pressure and temperature is described. The method used measures the time required for an expansion wave to travel a known distance through the test medium. The results of the sonic velocity measurements are presented for normal hydrocarbons from C_6 to C_{16} for temperatures and pressures from 60 to 250 F and 0 to 5000 psig, respectively. The density of the hydrocarbons was also determined.

The absolute viscosity of the test compounds was determined by use of a rolling-ball viscometer for pressures from 0 to 6000 psig in the temperature range given.

Tabulated and graphical results are presented for adiabatic bulk modulus, density, and absolute and kinematic viscosity for the range of hydrocarbons tested.

Heat-Transfer Characteristics of Hot Film Sensing Element Used in Flow Measurement..59—A-172... By S. C. Ling, Lintronic Laboratories, Farmington, Conn. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

The static and dynamic heat-transfer characteristics of several forms of hot-film elements used in flow measurement are presented. These characteristics are defined in terms of external heat-transfer resistance and internal heat-transfer impedance, and from these terms the frequency response of a probe element is derived. General characteristics of various probe forms are given.

The hot-film sensing element described has solved one of the most severe limitations in the art of hot-wire anemometry which requires interdependency of necessary electrical wire resistance for sufficient signal-to-noise ratio and necessary physical size of wire for mechanical strength.

For sufficient signal strength, hot wire of the order of 0.0004 cm is commonly used. In the case of hot film, the film resistance is no longer dependent on the physical size of probe form, and thus optimum signal and mechanical strength are possible.

In presenting the general characteristics of a hot film, emphasis has been stressed to bring a clear physical picture of the complex dynamic heat-transfer action involved.

Influence of Orifice Geometry on Static Pressure Measurements..59—A-234... By R. E. Rayle, Mem. ASME, Army Section (FFAAT), USTDC/MAAG, San Francisco, Calif. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

In measuring the static pressure of a fluid flowing past a surface, a knowledge of the effect of the shape and size of the pressure-tap orifice in the surface is useful in computing a more accurate estimate of the static pressure of the fluid. A review of the literature indicated a need for further investigations with improved equipment.

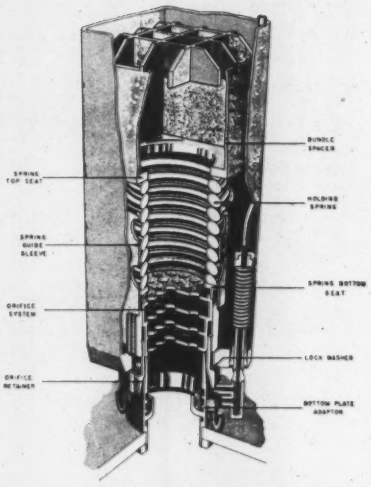
The equipment was designed to provide information on the static-pressure error due to variation in hole sizes from 0.006 to 0.125 in., orifice geometry, including countersinks and rounded edges, holes inclined up and downstream, variation of errors between water and air as a fluid, effect on error of change of Mach number, and the effect of varying the distance downstream from a nozzle.

The investigation was done in the Mechanical Engineering Department of Massachusetts Institute of Technology, and much of the test equipment was fabricated at Watertown Arsenal, Watertown, Mass.

Variable Flow Resistance With Adjustable Multihole Orifice Plates in Series..59—A-182... By J. Sherman, F. A. Grochowski, Assoc. Mem. ASME, and J. E. Sharbaugh, Assoc. Mem. ASME, Westinghouse Electric Corporation, Pittsburgh, Pa. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

In PWR, a water-moderated and cooled nuclear reactor for power generation, fuel elements are contained within assemblies, and the assemblies are arranged such that they create many individual closed parallel flow paths between plenum chambers of a containing pressure vessel.

The power distribution across the PWR core, which consists of many fuel assemblies, is uneven and, to utilize the available coolant flow efficiently, the flow rate to individual assemblies is apportioned according to their power generation. Because of the design and the flow characteristics of the assemblies, to achieve the desired distribution of flow, resistance must be added to certain assemblies.



Flow-resistance scheme employed in the fuel assemblies of a PWR core. This method shows the use of multihole orifices modified to provide means by which alternate plates can be rotated to change the hole alignment of successive plates, thus changing the resistance to flow (59—A-182).

To alleviate flow distribution problems imposed by a single-hole sharp-edge orifice, multihole orifices were considered, which led to multihole orifices in series, in which the holes of successive plates are misaligned to increase the flow resistance at a relatively low water velocity.

Tests performed on the multihole orifices in series showed that a considerable range of flow resistance could be obtained when the alignment of penetrations is varied.

Experimental Determination of Statistical Properties of Two-Phase Turbulent Motion..59—A-59... By S. L. Soo, Mem. ASME, H. K. Ihrig, Jr., Assoc. Mem. ASME, University of Illinois, Urbana, Ill.; and A. F. El Kouh, Allis-Chalmers Manufacturing Company, West Allis, Wis. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

The two-phase flow stream to be referred to here consists of solid particles suspended and conveyed by a turbulent gaseous stream. Systems involving two-phase streams are many, including pneumatic conveying devices, combustors of solid and liquid fuels which have been used for a long time; more recently,

solid-propellent rockets, H-iron processes; and still more up to date, the nuclear-propulsion devices in which the temperature is such that erosion of refractories has to be considered.

Experimental studies on the over-all character of momentum transfer of a two-phase stream have been made, notably the measurement of pressure-drop characteristics in pipe flow. These results furnish adequate data, for instance, for the design of a pneumatic conveying system.

In many cases, however, some statistical details of the motion of the two phases are needed, especially where momentum transfer is the primary contributor to other transport processes.

The scope of this paper entails the determination of the turbulence characteristics of both the solid and fluid phases of the two-phase stream. The stream is a fully developed turbulent air stream flowing horizontally and transporting spherical glass beads of close size range. Two basic experimental techniques are used. The turbulence of the fluid phase is determined by using a tracer-diffusion technique. The turbulent motion of solid particles is determined by using a photo-optical technique.

Heat Transfer

Thermal-Contact Resistance in Finned Tubing..59—A-135... By K. A. Gardner, Mem. ASME, Yuba Consolidated Industries, Palo Alto, Calif.; and T. C. Carnavos, Mem. ASME, The Griscom-Russell Company, Massillon, Ohio. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1960).

Interference-fit finned tubes depend for their heat-transfer capability upon a contact pressure between fin and tube. The bond resistance under such conditions is relatively small compared to the other resistances in the heat-flow path. At elevated temperatures, however, differential thermal expansion between fins and tubes completely relaxes the contact pressure and introduces an additional gap resistance; this may become a significant part of the total resistance to heat transfer.

A theoretical method for predicting the gap resistance is derived in terms of the fin and tube dimensions, their physical properties, the fluid temperatures and heat-transfer coefficients, and the initial contact pressure. Test data on five finned-tube units representing embedded, tension-wound, and muff-type fins are given in graphical and tabular form. Very good agreement is found between theory and test in two of the interference-fit units. The other two show only fair agreement.

Heat-Transfer Performance of Condenser Tubes..59—A-225... By J. A. Stawicki, Mem. ASME, and J. S. Ungar, Mem. ASME, Consolidated Edison Company of New York, Inc., New York, N. Y. (multilithographed; available to Oct. 1, 1960).

In a power plant, the equipment most likely to receive little attention is the condenser. Consequently, it is given little care until serious difficulties develop with its operation and with that of its associated auxiliaries.

Deterioration of condenser performance not only increases the operating costs but also limits the turbogenerator capacity for a given throttle steam flow. The condenser performance is impaired by the fouling of the condenser tubes.

In order to keep such impairment at a minimum an improved adaptation of a single-tube calorimeter has been used successfully to evaluate the degree of fouling and to determine whether extensive or routine corrective measures are necessary to restore good performance. This calorimeter is useful for determining the effectiveness of fouling preventatives, for selecting the best alloy for condenser tubes, and for perfecting condenser acid wash technique.

Covered in the paper are the effect of acid-bath temperature on quality of the condenser wash, the effect of nonchlorination of circulating water of condenser performance, the effect of iron-sulfate solution on heat transfer, and relative heat-transfer coefficients of condenser-tube alloys.

The single-tube calorimeter has proved to be a valuable instrument for safeguarding the best practicable condenser performance obtainable.

Sensory Reception and Control of Temperature in Man..59—A-214... By T. H. Benzinger, Naval Medical Research Institute, Bethesda, Md. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

With x rays and amplified thermoelectric recordings, the intracranial measurement of human body temperature is introduced and described. The paper is an attempt to clarify the autonomic mechanism of human temperature control in warm environment. Gradient-calorimetry experiments are described.

Experimental evidence is presented for the finding that internal thermoceptors, not skin temperature, are the sensory components of human temperature control.

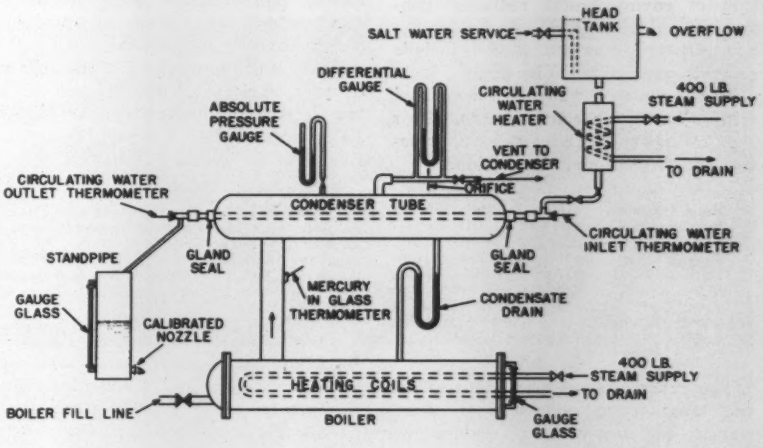
A quantitative analysis of this vital automatic control mechanism, the physiological defense against overheating by means of controlled sweat secretion and cutaneous blood circulation, is derived from data obtained with the human gradient calorimeter and additional methods for measuring cutaneous and cranial temperatures.

For every increase of 1/100 C of internal cranial temperature, above the critical threshold, sweat evaporation increases by one cal per sec and cutaneous circulation by 0.25 ml per sec.

Local and Average Heat-Transfer and Pressure-Drop for Refrigerants Evaporating in Horizontal Tubes..59—A-278... By M. Altman, General Electric Company, Philadelphia, Pa.; R. H. Norris, Mem. ASME, and F. W. Staub, Assoc. Mem. ASME, General Electric Company, Schenectady, N. Y. 1959 Annual Meeting paper (multilithographed; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1960).

Increasing emphasis is being placed on the optimization of evaporators. Airborne refrigerant evaporators in particu-

Schematic diagram of a single-tube calorimeter condenser-testing apparatus (59—A-225)



lar have placed a premium on minimum size and weight. An improved knowledge of the local evaporating heat transfer and pressure drop is therefore mandatory before true optimization can be accomplished.

A test facility is described that has been construed to investigate local heat transfer and pressure drop for evaporating or condensing refrigerants. The empirical method of B. Pierre for correlating the average heat-transfer coefficients of refrigerants evaporating in horizontal tubes is presented in conjunction with the data of several authors.

Experimental equipment designed and constructed at the General Engineering Laboratory of the General Electric Company to determine the local heat transfer and pressure drop for evaporating or condensing refrigerants is briefly described. Preliminary data on the local heat transfer and pressure drop for Refrigerant-22 evaporating in a 0.343-in-ID, 4-ft-long horizontal tube are presented.

The Martinelli-Nelson method of calculating two-phase pressure drop inside pipes was extended for use with Refrigerant-22 and was then employed to correlate the pressure-drop data in this investigation.

Prediction of Heat-Stressed Skin Boundary Temperatures..59—A-209... By L. P. Herrington, The John B. Pierce Foundation, New Haven, Conn. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

A four-element linear differential equation is developed from human calorimetric data for the prediction of human thermal response in the 80 to 105 F range.

In the bioengineering of thermally complex environments, resultant mean skin-boundary temperature is an important predicted datum. Prior equational condensations quantifying the joint action of environmental radiation convection and biological heat production and evaporation are extended to include an environmental humidity term.

Partial rates of change are associated with (*a*) operative temperature and vapor pressure, and (*b*) with operative temperature, metabolism, and evaporation.

Heat-Transfer and Flow-Friction Characteristics of Crossed-Rod Matrices..59—A-168... By A. L. London, Mem. ASME, J. W. Mitchell, Stanford University, Stanford, Calif.; and W. A. Sutherland, Assoc. Mem. ASME, General Electric APED, San Jose, Calif. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct., 1, 1960).

The paper presents a continuation of the program on porous media heat-transfer and flow-friction behavior previously covered. All the previous results of interest to the designer on woven-screen matrices and crossed-rod matrices of a random configuration are summarized here.

In addition, new design results for the regular in-line and regular staggered crossed-rod-matrix configurations are reported. Matrices of the type considered here may find application as heat-transfer surface geometries for nuclear-reactor fuel elements, for electrical resistance heaters, and for periodic-flow-type heat exchangers used for gas-turbine regenerators, and some air-conditioning applications.

The Effective Stimulus for Warmth Sensation in Man..59—A-208... By E. Hendler, Naval Air Material Center, Philadelphia, Pa., and J. D. Hardy, University of Pennsylvania, Philadelphia, Pa. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

Considering the relatively superficial location of the cutaneous temperature receptors and the fairly direct manner by which they may be stimulated, it may appear paradoxical that so little is known about them.

But the close scrutiny of the pertinent anatomical and physiological literature reveals a multitude of conflicting interpretations regarding the observations made. Recent evidence has been accumulating which indicates that the cutaneous receptors may be morphologically undifferentiated nerve endings lying at all levels throughout the dermis and epidermis, up to and including the stratum granulosum.

This paper gives theories concerning temperature receptors and describes in detail one experiment on the mechanism of temperature sensation.

Using a near infrared thermal source, the central forehead skin (blackened and unblackened) of a subject was exposed to various pulse-duration energy-intensity combinations in order to produce threshold warmth sensation.

Analysis of the results indicate that a temperature rise of about 0.02 C occurring at an intracutaneous depth of about 150 to 200 microns results in a threshold warmth sensation.

Remarks on the Temperature Step Functions on a Flat Plate in Forced Convection..59—A-188... By H. H. Sogin, Assoc. Mem. ASME, Brown University, Providence, R. I. 1959 Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

Some common properties of the step functions for laminar and turbulent boundary layers are discussed. Then they are developed from a self-suggested relationship between a generalized step function and the function that arises from the energy integral equation when the velocity and the temperature profiles are similar but disparate.

When additional details are examined, it is found that the generalizations are fortuitous.

An Experimental Study of the Effects of Nonuniform Wall Temperature on Heat Transfer in Laminar and Turbulent Axisymmetric Flow Along a Cylinder..59—A-151... By E. Eichhorn, Princeton University, Princeton, N. J.; E. R. G. Eckert, Mem. ASME, University of Minnesota, Minneapolis, Minn.; A. D. Anderson, Research Center, NASA, Moffett Field, Calif. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1960).

Measurements of both the hydrodynamic and thermal characteristics of flow over an axial cylinder at subsonic speeds are reported. It was found that the boundary layer along an axial cylinder tends to become asymmetrical as it approaches the transition point. This asymmetry vanishes again in turbulent flow.

For both laminar and turbulent flow, the average boundary-layer growth could be predicted by the standard flat-plate relationships, and simple methods were deduced for determining the effective hydrodynamic length of the boundary layers. Local and total heat-transfer measurements were made with both laminar and turbulent flow for various unheated starting lengths followed by linearly increasing wall temperatures.

For laminar flow, agreement with theory was obtained, this agreement being improved by the Seban and Bond cylindrical curvature correction. The turbulent-flow results indicated preference for the theory of Seban. Isothermal equations represent turbulent heat transfer within approximately 20 per cent when the wall-temperature variations are not too abrupt.

The Role of the Skin in Heat Transfer..59—A-138... By A. M. Stoll, U. S. Naval Air Development Center, Johnsville, Pa. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1960).

The author considers lines of fundamental research and the impact of human factors in the area of thermal exchange. Logically, this area of investigation may be divided into: (a) Heat exchange between man and his environment, and (b) internal energy balance between heat production and heat loss.

Very little information has been compiled in an orderly fashion concerning the skin through which heat must flow in both directions to maintain man in his environment in a functional capacity.

It is therefore the purpose of this paper to consider the human skin, its dimensions and properties with respect to its role in heat transfer, and the effects of its impairment or injury.

Heat Transfer to Liquid Metals With Variable Properties..59—A-148... By R. Viskanta and Y. S. Touloukian, Mem. ASME, Purdue University, Lafayette, Ind. 1959 Annual Meeting paper (in type: to be published in **Trans. ASME—J. Heat Transfer**; available to Oct. 1, 1960).

The problem of heat transfer to liquid metals with variable physical properties for the case of fully developed turbulent flow in cylindrical tubes of constant diameter is studied, the fluid considered being heated or cooled by a constant and uniform heat flux at the wall.

The similarity theory between momentum and heat transfer is used. Using the von Karman universal velocity profile the differential equations for turbulent flow with heat transfer are solved for the Prandtl number and the kinematic viscosity, each having five different sets of temperature-dependent exponents of a_1 and a_2.

Calculated temperature distributions, mixing-cup temperatures, as well as relations between Nusselt versus Peclet numbers are presented for the cases of heat addition, heat extraction, and the nonvariable-property case.

Climatic Considerations in the Design of Air-Cooled Heat Exchangers..59—A-255 ... By G. F. Collins, and R. T. Mathews, Mem. ASME, E. I. du Pont de Nemours and Company, Inc., Wilmington, Del. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

It is important, both in the practical and economical application of air-cooled exchangers, to give careful consideration to climatic and environmental factors.

The environment in which the air-cooled exchanger is located can affect its performance, required materials of construction to resist atmospheric corrosion, and the amount of required maintenance.

The hot-air discharge from these exchangers, if improperly located, can endanger operating personnel and reduce the operating effectiveness of other equipment. A knowledge of the coincident dry and wet-bulb temperatures for any location will allow improved performance of the air-cooled exchanger by supplementary evaporative cooling during extreme hot-weather periods.

This paper considers these factors and their important effect on the design of air-cooled exchangers.

The effect of design temperature and other climatic parameters, such as rain, hail, solar radiation, wind, and air movement on the equipment is also considered.

Thermal Comfort in Space Vehicles..59—A-207... By J. E. Janssen, Mem. ASME, Minneapolis Honeywell Research Center, Hopkins, Minn. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

Consideration of the problem of thermal comfort in man-carrying space vehicles may seem premature at this stage of development. However, extended space trips to the moon and planets will require long exposure to conditions which may create both physical and emotional stress.

A "shirt-sleeve" environment in the cabin of the vehicle will be required. The proper conditions for this environment are discussed. Since gravity forces are quite small in space, free or natural convection will be negligible.

Since the condition of thermal comfort is dependent on the environmental conditions, it is important to know the relationship among the various factors which influence the balance between body-heat-loss and heat production.

Equations based on existing calorimetric data on human-body heat loss are presented which separate the thermal radiation and convective effects. A new forced-convection, heat-loss term was then derived to make the Earth-bound comfort equation valid for the case of a space-vehicle cabin. The results indicate that thermal radiation is a considerably more important comfort variable in a space ship than in an Earth-bound environment.

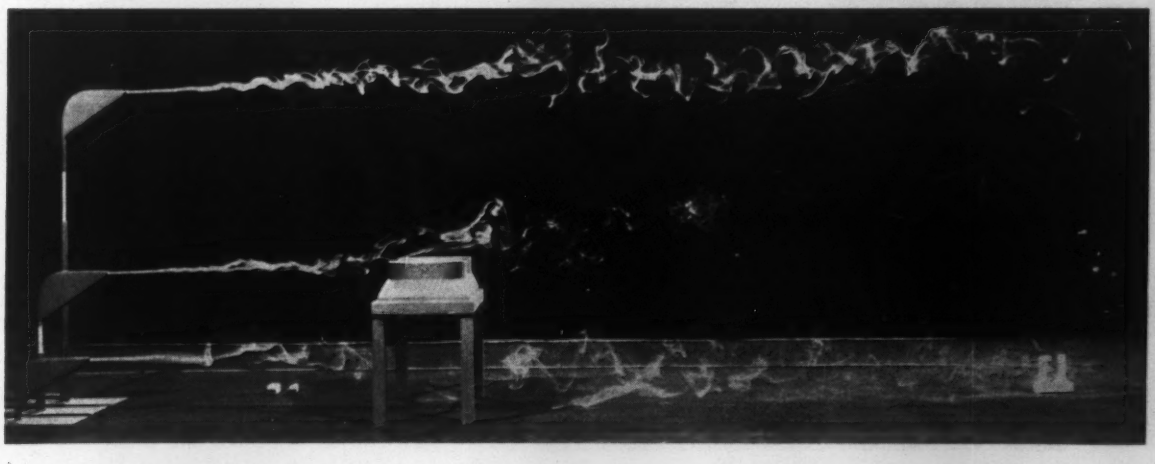
Geometric Factors for Radiative Heat Transfer Through Absorbing Medium in Cartesian Co-Ordinates..59—A-206... By A. K. Oppenheim, Mem. ASME, and J. T. Bevans, Mem. ASME, Shell Development Company, Emeryville, Calif. 1959 ASME Annual Meeting paper (multilithographed; to be published in **Trans. ASME—J. Heat Transfer**; available to Oct. 1, 1960).

The evaluation and prediction of process furnace performance require an accurate determination of the heat transfer from the combustion gases and the furnace enclosure to absorbing surfaces. A primary mechanism for this transfer is the radiant exchange between the combustion gases, the enclosure walls, and the absorbing area.

In the past, the methods of detailed analysis have been too complicated for practical application and sufficient information was not available regarding radiant properties to make an accurate analysis.

As a consequence, methods of semi-empirical form have been developed which represent by a single variable, all elements of the furnace that have a common function. These procedures permit

A model of an induced-draft, air-cooled exchanger placed in a wind tunnel to indicate the effect of recirculation. Very little recirculation would occur with this type of open exchanger (59—A-255).



an over-all system behavior to be determined but do not allow any examination of variations in such variables as heat flux of temperature occurring within the furnace.

The development of the network method of radiant exchange analysis has provided a practical procedure for making a more detailed study of the radiation within a furnace. The application of this method is presently restricted by the lack of knowledge of the properties of radiant systems.

In addition to the obvious physical properties of the surfaces and gases within the furnace, an important property of a radiation system is the geometrical relationship between the various surfaces which comprise the system. The geometrical factors for two surfaces separated by a nonabsorbing medium have been determined for a large number of geometries.

Computations for surfaces separated by an absorbing medium have not been performed for comparable varieties of geometries and dimensions.

The paper describes a method for determining the geometric factors for parallel opposed equal rectangles and perpendicular adjacent unequal rectangles with an intervening absorbing medium. These two basic shapes can be used to compute the geometric factors for any arrangement of parallel or opposed rectangles with the aid of flux algebra.

Certain Thermodynamic and Transport Properties of the Atmospheres of Venus, Mars, and Jupiter..59—A-102... By W. E. Ibele, Assoc. Mem. ASME, and T. F. Irvine, Jr., University of Minnesota, Minneapolis, Minn. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1960).

Aerodynamic, heat-transfer, biological, and other scientific investigations related to planetary systems require a knowledge of atmospheric properties. In the absence of direct measurements within these atmospheres, which is the situation existing for all planets except Earth, the properties must be estimated from the best available data by suitable methods. Since atmospheres may be considered as mixtures of constituent gases, it is possible, in principle, to calculate their properties using basic-mixture theory.

The chief difficulty in this approach lies in the uncertainty of present physical models of atmospheres; i.e., the number, type, and concentration of the constituent gases. For example, it has been concluded that present planetary atmospheric models are only order-of-magnitude estimates.

This situation is comparable to the state of knowledge regarding the upper regions of Earth's atmosphere prior to the 1957–1959 International Geophysical Year. Nevertheless, the predictions available until that time served a useful purpose in stimulating research in various atmospheric phenomena. In this spirit, the atmospheric calculations in the present study were undertaken.

In addition to altitude variations of pressure, density, and temperature, planetary atmospheric properties of interest include thermodynamic energy functions (internal energies, enthalpies, entropies, and so on) and transport properties such as viscosities, coefficients of diffusion, and thermal conductivities. Also useful for certain applications are supersonic shock tables and atmospheric radiation properties.

The purpose of this paper is to present certain of the thermodynamic and transport properties for the selected atmospheres of Venus, Mars, and Jupiter. Information is given on the specific heat, acoustic velocity, dynamic viscosity, thermal conductivity, and Prandtl number over a temperature range from 200 to 1500 deg Kelvin (K). The property variation with temperature was included so that phenomena occurring under temperature extremes likely to be encountered in the atmospheres could be considered.

A Systematic Approach to the Design of Compact Heat Exchangers..59—A-193... By Wickliffe B. Hendry, Mem. ASME, Westinghouse Electric Corporation, Kansas City, Mo. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

The problem of designing a direct-transfer, cross-flow, single-pass heat exchanger of minimum volume is stated as a system of 17 equations. Four parameters, two for each surface, are developed from these equations.

These parameters serve as a guide in the development of improved surfaces and provide a numerical basis for isolating a small number of the better surface combinations for a given application. The best of these surface combinations may then be selected by a conventional method. The analysis may be readily extended to include the design of a heat exchanger of minimum weight.

The Prediction of Human Thermal Tolerance When Using a Ventilating Garment With an Antiexposure Suit..59—A-114... By J. W. McCutchan, Mem. ASME, University of California, Los Angeles, Calif.; 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1690).

The physiological responses of human subjects have been investigated in the thermal environments ranging from 120 to 240 deg F while wearing the MA-2 ventilating garment, an MK-IV exposure suit, and other garments comprising 2.15 clo[2] of thermal resistance. The ventilating garment was given air inputs ranging from 2 to 14 cfm in volume, and from 50 to 90 F in temperature.

The thermal responses of the subjects are shown graphically in terms of heat storage, heart rates, sweat rates, and composite indexes of these variables. The results of these experiments have been prepared in terms of an equation which is presented graphically as a nomograph. This nomograph predicts the cooling power of the MA-2 ventilating garment and is to be used in conjunction with the tolerance chart.

The tolerance data, which were determined on steady exposures in a preheated chamber, are used to predict human tolerance for conditions where the air and wall temperatures are not constant.

Application of Variational Methods to Radiation Heat-Transfer Calculations. 59—A-120... By E. M. Sparrow, Assoc. Mem. ASME, Lewis Research Center, NASA, Cleveland, Ohio. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1960).

Following a long period of relatively moderate research activity, an upsurge of interest in radiation heat transfer has recently taken place. This renewed importance of radiation arises from its application to space technology. Not only does radiation provide a workable means for transferring waste heat from space vehicles, but also it will serve as a dominant heat-transfer mechanism in power plants of the future.

In this paper, a variational method is presented for solving a class of integral equations which arise in radiation heat-transfer problems.

First, to demonstrate the formulation of radiation problems in terms of integral equations, consideration is given to a system consisting of two nonblack, finite, parallel plates. After a general description of the variational method, its use is illustrated by application to the parallel-plate system. Comparisons are made which show very good agreement with exact solutions.

Thermal Radiation From a Cylindrical Enclosure With Specified Wall Heat Flux..59—A-159... By C. M. Usiskin and R. Siegel, Assoc. Mem. ASME, Lewis Research Center, NASA, Cleveland, Ohio. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1960).

Thermal radiation is considered from the inside surface of a heated cylindrical

enclosure. A specified heat input is imposed at the enclosure wall and the surface temperature distribution is determined.

The analysis considers both black and diffuse gray-body radiation and obtains a simple relation between the two. The energy equation, which is a linear integral equation, is solved by three methods: (a) Use of a separable kernel, (b) numerical integration, and (c) variational methods.

A Theoretical Analysis of a Peltier Refrigerator..59—A-266... By E. B. Penrod, Mem. ASME, University of Kentucky, Lexington, Ken. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

The Peltier refrigerator considered in this paper consists of a single thermocouple that is connected to a direct-current power supply.

A wave equation in the form of a first-degree, second-order differential equation with constant coefficients is derived from fundamental principles of thermodynamics and heat transfer.

The coefficients are dimensionless ratios that connect four heat-power terms. Particular solutions are obtained from which various equations are developed that are useful in designing a Peltier refrigerator.

Transient Temperatures and Thermal Stresses in Hollow Cylinders Due to Heat Generation..59—A-144... By J. E. Schmidt, Assoc. Mem. ASME, Westinghouse Bettis Atomic Power Division, Pittsburgh, Pa.; and George Sonnemann, Mem. ASME, University of Pittsburgh, Pittsburgh, Pa. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1960).

A general solution for the transient temperatures and thermal stress is obtained for a right circular cylinder with internal heat generation varying exponentially with the radius by use of Hankel transforms.

Curves for the maximum thermal stresses are presented for diameter ratios up to 1.2 and for a variety of internal heat-generation rates for internal heat-generation transients with both cylinder walls maintained at zero reference temperature at all times.

Heat Transfer and Effectiveness for a Turbulent Boundary Layer With Tangential Fluid Injection..59—A-177... By R. A. Seban, Mem. ASME, University of California, Berkeley, Calif. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1960).

Experimental results are presented for the effectiveness and for the heat-transfer coefficient for a film cooling system in which air was used both for the film and for the free-stream fluids.

Injection occurred at a single tangential slot near the leading edge of the plate and the slot size was varied. All flows were turbulent and the injection velocities covered a range from much less to much greater than the free-stream velocity.

Correlations are realized for both the effectiveness and for the heat-transfer coefficient and, as in the past experience with such systems, separate specifications are needed for injection velocities greater and less than the free-stream velocity.

The Effect of Apparent Density and Gas-Cell Size on the Thermal Conductivity of Cellular Materials..59—A-254... By M. E. Stephenson, Jr., Assoc. Mem. ASME, Raytheon Company, Wayland, Mass.; and Melvin Mark, Mem. ASME, Lowell Technological Institute, Lowell, Mass.

A knowledge of the fundamental relationships which relate the thermal conductivity of cellular materials to their cell size and shape, apparent density, and material-property values is of interest, since the application of these substances as insulation is quite common. The various mechanisms of heat transfer through such materials are considered and evaluated.

Thermal conductivity is not a unique function of apparent density, cell size being in many cases a more important parameter. In the case of a material made up of large numbers of cells, a simplified model is considered and a relationship derived between the geometrical parameters which determine the apparent density and gas-cell size, and the heat-transfer parameters which influence the gas conduction, solid conduction, radiation, and convection.

Certain general conclusions are checked qualitatively with existing experimental data on plastic foams. For the case of a cellular material of constant wall thickness, a minimum value of thermal conductivity at an "optimum" value of apparent density is predicted; this is compared with existing experimental data on fibrous materials of constant strand diameter.

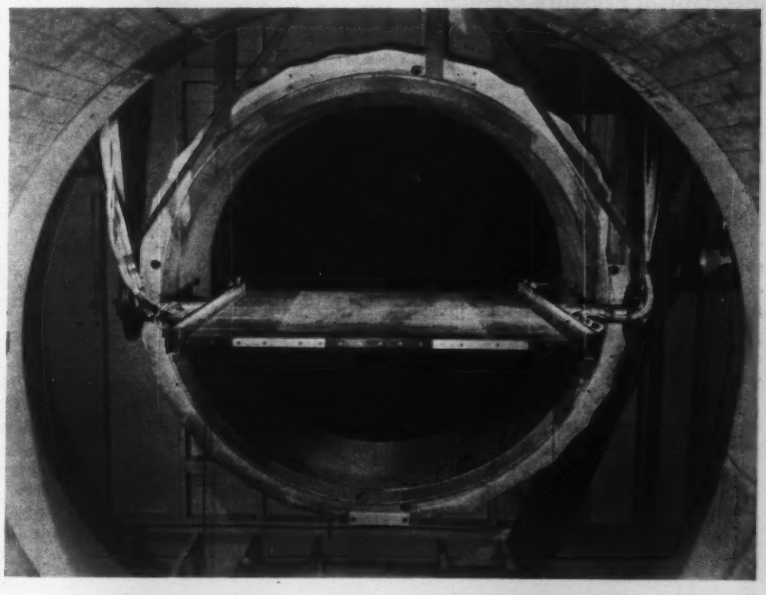
For honeycomb materials approximate methods of estimating the thermal conductivity are discussed and the effect of apparent density and gas cell size studied in relation to experimental data on honeycombs of various dimensions and materials.

A Summary of Experiments on Turbulent Heat Transfer From a Nonisothermal Flat Plate..59—A-157... By W. C. Reynolds, Mem. ASME, W. M. Kays, Mem. ASME, and S. J. Kline, Mem. ASME, Stanford University, Stanford, Calif. 1959 Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1960).

The results of an extensive experimental investigation of heat transfer to a turbulent incompressible boundary layer from a nonisothermal flat plate are summarized. Data presented extend the range of low-Mach-number confirmation of the von Karman analogy to Reynolds numbers of 4×10^6 for an isothermal plate.

Data for a step wall-temperature dis-

A flat plate installed in a wind tunnel from inside of downstream collector. The thermocouple, power, and pressure leads can be seen coming from the sides of the plate (59—A-157).



tribution confirm experimentally the preferable expression for this important superposition kernel case. Data from a variety of other examples confirm the use of the superposition theories to predict heat transfer from nonisothermal surfaces.

The Apparent Thermal Conductivity of Fibrous Materials..59—A-293... By J. J. Thigpen, Mem. ASME, Louisiana Polytechnic Institute, Ruson, La.; and B. E. Short, Fellow ASME, The University of Texas, Austin, Tex. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

Thermal conduction through materials is said to be due to direct contact between the particles of which the material is made without large-scale motion of groups of the particles.

As a general rule, a material is a good thermal insulator if it contains a high percentage of small spaces which contain a gas.

An equation for the apparent thermal conductivity of fibrous materials is presented which is based on a structural model composed of square fibers arranged parallel to each other in the same plane but perpendicular to the fibers of the adjacent plane layer, the planes of the fibers being perpendicular to the heat-flow path.

Results from this equation are compared with results from similar equations by Nusselt and Eucken for porous materials. These values are also compared with commercial data and data from similar experiments with various gases in the voids.

Mechanical Pressure Elements

Analysis of Axially Loaded Annular Shells With Applications to Welded Bellows..59—A-175... By M. Heténi, Mem. ASME, Northwestern University, Evanston, Ill.; and R. J. Timms, Sperry Gyroscope Company, Great Neck, N. Y. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

A method is presented for the calculation of stresses and deflections in ring-shaped shells of circular cross section, subjected to axial forces. The solution is derived without the restriction imposed for toroidal shells by previous investigators, that the radius of curvature of the cross section is to be small in comparison with the mean radius of the torus.

The range of applicability of the method is extended hereby to include the slightly arched convolutions used in the construction of welded bellows. By a rational reduction of the general solution, approximate design formulas are obtained for the maximum stresses and deflections in bellows under axial forces and the calculated values are compared with experimental data.

Power Test Codes

Temperature Measurement in Moving Fluids..59—A-257... By R. P. Benedict, Assoc. Mem. ASME, Westinghouse Electric Corporation, Lester, Pa. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

This paper deals with the problem of temperature measurement in a moving fluid. Thermodynamic temperatures are defined for thermal states of statistical equilibrium only. Such states are seldom encountered in practical thermometry, so the usual temperature concept must be modified. Of the nonstatic effects which most frequently beset the practicing "pyrometrist," none are more important than those encountered when the fluid (considered as a continuum) is characterized by a directed kinetic energy of flow superposed on the random velocities of the molecules.

To create an understanding why temperature measurement in a moving fluid presents difficulties, ideas concerning idealized fluids, idealized temperature-sensing probes, and idealized temperature relations are reviewed. Then how these relations must be modified when considering the practical measurement of temperature in real moving fluids are examined.

A dynamic correction factor (K) is defined to indicate real fluid and real probe effects. Some recent experimental data for three representative probe geometrics (bare wire, pencil, half-shielded types) are presented in terms of K versus the Mach number. Use of the K-factor is illustrated by two examples. Finally, a selected bibliography of related work is given.

Throat Tap Nozzles Used for Accurate Flow Measurements..59—A-174... By K. C. Cotton, Mem. ASME, and J. C. Westcott, Mem. ASME, General Electric Company, Schenectady, N. Y. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Power**; available to Oct. 1, 1960).

The history of the design, manufacture, calibration, and use of 17 nozzles built by the General Electric Company for accurate flow measurements in conducting performance tests on large steam turbine-generator units is presented.

It is important to note that the requirements and procedures established are based on the philosophy of eliminating all known errors that affect the flow measurement by 0.1 per cent or greater. The economic justification for this philosophy is the fact that the performance of very large steam turbine-generator units has been evaluated as high as $700,000 per 1 per cent.

Theory and Applications of Strain-Gage Torque-Measuring Devices..59—A-314... By H. E. Lockery, Baldwin-Lima-Hamilton Corporation, Waltham, Mass. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

The precise measurement of torque is fundamental to the accurate measurement, optimization, and control of transmitted torque and power, for the precise measurement and totalization of transmitted energy, and, in static applications, for the precise calibration of torque wrenches.

A variety of torque-measuring devices have been developed. In order to appreciate the uniqueness of the performance characteristics of the strain-gage torque transducer and to understand its performance characteristics, available typical torque-measuring devices currently available are reviewed.

Special applications of the device are presented to illustrate the broad field of application enjoyed by the bonded strain-gage torque transducer in the measurement of torque, horsepower, and energy.

Production Engineering

Flow Turning to Increase Strength, Save Weight, and Reduce Costs..59—A-277... By J. H. Peters, Pratt & Whitney Aircraft, East Hartford, Conn. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

Pratt & Whitney Aircraft has devoted all of its efforts to the development and manufacture of dependable, efficient, and reasonably priced flight-propulsion devices since its founding in 1925. During this period, countless manufacturing processes and tooling techniques had to be developed to produce economically the efficient, high-performance components of aircraft and missile power plants.

This paper deals with one such development whereby a little known pot, pan, and metal television tube technique has been applied to highly stressed structural and pressure vessel parts to increase strength, save weight, and reduce costs.

"Flow turning" is the coined name applied to the roll-forming technique used at the author's company in the production of coefficient, dependable flight-propulsion components. The various types of flow turning are described and several of the strength, weight, and cost advantages are discussed. Pictures and drawings are included to show the principles involved, parts produced, and some of the machine equipment used.

New Developments in Plant Layout Techniques..59—A-204... By J. M. Apple, Mem. ASME, Industrial Management Consultant, East Lansing, Mich. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

The procedures and techniques of modern plant layout have grown out of the old-fashioned "cut-and-try" methods. These have been refined by the adoption of the engineering approach, the application of more scientific procedures of planning and analysis, and implemented by easier and more economical techniques for the actual layout construction.

Sources of plant-layout problems are described and the term "plant layout" is defined as planning and integrating the paths of the components of a product to obtain the most effective and economical interrelationship between men, equipment, and the movement of materials from receiving through fabrication, to the shipment of the finished product.

Included in the discussions are the sources of plant-layout problems, objectives of plant layout, relationship between plant layout and materials handling, and general procedure in plant layout.

The author concludes that no layout project is routine, that the procedure described is intended only as a guide in solving plant-layout problems, and that each plant-layout engineer must use thorough consideration of all aspects of his own project.

Planning Human Environment Into Industrial Processing..59—A-317... By Leonard B. Wocholski, General Motors Institute, Flint, Mich. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

In all fields of engineering, techniques have been extended to provide the engineer with better tools in order to solve problems more quickly and more accurately. In this advancement of engineering, the concepts of human environment as related to industry have lagged. Therefore this paper presents some of the concepts which may give the engineer a better understanding of the requirements of a worker when exposed to a high sensible heat and/or to a high-humidity condition.

Considerations to be used in the design of industrial processes presented are:

1 The proper level of warmth as related to workers.

2 Factors which affect the feeling of warmth.

3 The interrelation of total heat loss, sensible heat loss, and the evaporative heat loss from people.

4 The physiological response of workers.

Emphasis is placed on the problem dealing with thermally hot industrial processes which result in a hot atmosphere on workers. It is hoped that with a better understanding of these concepts, engineers will include as a major consideration the human requirements in the manufacturing planning stage.

ASME TRANSACTIONS

The April, 1960, issue of the Transactions of the ASME—*Journal of Engineering for Power* (available at $1.50 per copy to ASME Members; $3 to nonmembers)—contains the following:

Journal of
ENGINEERING FOR POWER

Volume 82 • Series A • Number 2

83 Critical Flow Velocities for Collapse of Reactor Parallel-Plate Fuel Assemblies, by D. R. Miller

96 The Propeller Turbines of the St. Lawrence Power Project, by G. G. Fintak. (59—Hyd-11)

103 Influence of Trailing-Edge Geometry on Hydraulic-Turbine-Blade Vibration Resulting From Vortex Excitation, by Gunnar Heskestad and D. R. Olberts. (59—Hyd-7)

111 Water-Hammer Damage to Oigawa Power Station, by C. C. Bonin. (59—Hyd-8)

120 An Experimental Investigation of Radial Thrust in Centrifugal Pumps, by A. Agostinelli, D. Nobles, and C. R. Mockridge. (59—Hyd-2)

127 Design and Test of Mixed-Flow and Centrifugal Impellers, by J. J. Kramer, W. M. Osborn, and J. T. Hamrick. (59—Hyd-20)

136 Volute Pressure Distribution, Radial Force on the Impeller, and Volute Mixing Losses of a Radial Flow Centrifugal Pump, by H. W. Iversen, R. E. Rolling, and J. J. Carlson. (59—Hyd-10)

145 Relationship of Coal-Ash Viscosity to Chemical Composition, by W. L. Sage and J. B. McIlroy. (59—Fu-4)

156 Pressurization of Granular Solid Fuels, by M. N. Aref. (59—A-150)

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COMMENTS ON PAPERS

The Tilt-Wing Propelloplane

Comment by W. Z. Stepniewski[1]

THE author should be congratulated for an excellent presentation of the case for the tilt-wing aircraft.

Being in full agreement with the basic philosophy of his paper,[2] I can only add a few general remarks regarding the competitive position of the tilt wing with respect to conventional aircraft.

Assuming that the initial cost of an aircraft is closely related to its weight empty and total power installed, while operational costs depend to some extent on power installed, it can be stated that aircraft belonging to the same gross-weight class having the same installed power loading, similar weight empty, and similar speed capabilities belong to the same economical class. Hence, how do those factors compare between tilt wing and conventional aircraft in various gross weight classes?

Fixed-wing aircraft of the 30,000 gross-weight class and capable of 350 mph of maximum speed would have an installed power of about 6 or 7 lb per hp. If the same demand for maximum speed would be made on transport fixed-wing aircraft of a lower gross weight (say about 15,000 lb) but having a practical size cabin, then in order to satisfy this speed requirement the installed power loading would drop to about 5 lb per hp. With this level of power loading it should not be too difficult to design a tilt-wing machine capable of hovering at altitudes up to 6000 ft on standard day, or 3000 ft and 85 F. Since, due to the possible decrease of the wing and control-surface area of the tilt wing, some weight savings in structural weight can be achieved; hence, weight empty of the tilt wing should not be much different from that of a conventional aircraft having the same installed power loading. It follows, hence, that in the 15,000 lb gross weight —350-miles per hour class, a tilt wing flown at hovering gross weight may become economically competitive with conventional fixed-wing aircraft. In the higher gross-weight class (about 30,000 lb) and for the same speed requirements (350 mph) the tilt wing, taking advantage of its good STOL characteristic, still can maintain its competitive position by being flown at gross weights in excess of its hovering weight.

However, in the gross weight class of 100,000 lb and higher, the conventional fixed-wing aircraft shows such high installed power loading (about 10 lb per hp or higher) that, economically, competitive position of the tilt wing both at hovering and STOL gross weight becomes rather doubtful.

It may be concluded that for medium subsonic speeds and gross-weight classes of smaller (15,000 lb) and medium (about 30,000 lb) aircraft, the tilt wing may be economically competitive with conventional fixed-wing aircraft, while for large transport category this economical competitive position seems to be improbable.

Author's Closure

The author would like to thank Mr. Stepniewski for his kind comments and his expansion of the analysis to cover the effect of size.

J. B. Nichols.[3]

[1] Assistant Vice-President of Engineering, Research, Vertol Aircraft Corp., Morton, Pa.

[2] J. B. Nichols, "Tilt-Wing Propelloplane," MECHANICAL ENGINEERING, vol. 81, December, 1959, pp. 52–56.

[3] Manager, advanced planning department, Hiller Aircraft Corporation, Palo Alto, Calif. Mem. ASME.

Clutch-Fluid Coupling-Hydraulic Torque Converter

IN THIS instance we have departed from our usual type of comment and present the questions and answers as were developed during the discussion following the presentation of the paper.[4]

Question. (*a*) Your chart on heat dissipation shows engine rpm at 1800 but plots output rpm to almost 200. A converter does not overdrive. (*b*) Also you show converter torque ratio falling below 1:1. This requires permanently grounded stator (not freewheeling) and means efficiency approaches zero. Please explain. (V. C. Moore, Supv. Ford Motor Company.)

Answer. (*a*) Output speed can go to 1980 rpm because of assumed ten per cent engine governor overrun. (*b*) Torque ratio can fall below 1:1 because stator is not freewheeled in our study. Efficiency must decrease toward zero as torque ratio falls below 1:1.

Question. How closely does a marine propeller resemble a fluid coupling in respect to slip versus load, loading of engine, and so on? (Kenneth Robinson, Project Engineer, McCulloch Corp.)

Answer. A marine propeller acts in much the same sense as the impeller of a fluid coupling. It absorbs torque directly as the square of the rotational speed. Efficiency of the marine propeller is lower because it is not contained in an enclosure.

Question. Do you recommend either torque converter or fluid clutch where specific speed is required under varying load? (Joe Baxter, Jr., Director of Research, The Black-Clawson Company.)

Answer. An output shaft governor can be used with a torque converter to maintain a reasonably constant speed with varying loads.

Question. Does a dry clutch which is slipped *briefly* allow drive flexibility and accomplish performance improvement similar to fluid coupling? (Kenneth Robinson, Project Engineer, McCulloch Corp.)

Answer. Yes, a clutch can be deliberately slipped briefly to take up minor shock loads.

[4] R. W. Bachmann, "Clutch-Fluid Coupling-Hydraulic Torque Converter," MECHANICAL ENGINEERING, vol. 81, December, 1959, pp. 67–69.

Question. In this paper[4] the author lists seven types of friction clutches. Is there any particular reason why electrically actuated units are not included? (J. B. Scudder, Sales, Warner Electric Brake and Clutch Company.)

Answer. Electrically actuated clutches may be included. Once any clutch is adjusted properly and fully engaged, it should give direct drive performance.

Question. Is the torque converter basically a speed-reducing device or will it actually amplify torque? Example: 200 ft lb in. at 1000 rpm, what would torque be out of torque converter at 1000 rpm? (A. L. Collins, Project Engineer, J. I. Case Company.)

Answer. All converters act as speed reducers to a certain degree, depending upon the speed ratio at which the prime mover is matched to the particular converter in mind. All converters multiply torque to a certain extent, depending upon specific load demands.

Question. What, if any, constant torque couplings are available for small instrument drives—power requirements usually oz-in. at relatively slow speeds. (Overload protection.) (W. H. Marlow, Mechanical Engineer, Lederle Laboratories.)

Answer. There are no fluid couplings in this size as such, but there are many slip-type or torque limiting clutches.

Question. In air-borne drives, where weight and volume are critical, mechanical clutches are required in spite of their poor dynamic performance. Would you care to comment on this? Example: Clutches are smaller for equal torque. (Harold Ferris, Bell Helicopter Corp.)

Answer. Fluid couplings admittedly take up more space, but they are being tested in some experimental helicopter drives.

Question. Can you define the efficiency range of a typical torque (single-stage) converter performance in an automobile from standing-start at full throttle?

Answer. Just as the vehicle starts moving, the converter efficiency, regardless of converter type or design, must start at zero. As the vehicle accelerates, converter efficiency increases to maximum or near maximum, depending on the high-speed load requirements.

For a given vehicle and engine, and for given transmission and drive-line ratios, a converter with high torque multiplication would accelerate the vehicle more quickly than a converter with lower torque multiplication; therefore peak efficiency would be reached sooner with the high torque multiplication converter.

REVIEWS OF BOOKS

Materials: Science, Properties, and Education

Elements of Materials Science
By Lawrence H. Van Vlack. Addison Wesley Publishing Co., Inc., Reading, Mass., 1959. Cloth, 6 × 9 in., xvi and 528 pp., $8.50.

Nature and Properties of Engineering Materials
By Zbigniew D. Jastrzebski. John Wiley & Sons, Inc., New York, N. Y., 1959. Cloth, 6 × 9¼ in. figs, tables, problems, references, index xvii and 571 pp., $11.

Symposium on Education in Materials
ASTM Special Technical Publication No. 263. American Society for Testing Materials, Philadelphia, 1960. Paper, vi and 51 pp., $2.

Reviewed by Glenn R. Fryling[1]

THIS review links together two recent undergraduate textbooks in materials engineering and a symposium sponsored in June, 1959, by the American Society for Testing Materials and the American Society for Engineering Education. Although these two texts are in a sense competitive with one another, there is enough difference in the educational level they are seeking to reach to write that each one, in its own way, achieves the objective striven for. The diversity of engineering college curriculums is such that the choice between the two may well be decided by the position of the materials course in the curriculum sequence.

The book by Professor Van Vlack of the department of chemical and metallurgical engineering at the University of Michigan is definitely an introductory text designed for freshman and sophomore engineering students with a background of general physics and chemistry. It requires no mathematical understanding beyond college algebra and trigonometry.

Professor Jastrzebski of the chemical engineering department at Lafayette College has written for sophomore, junior, or senior introductory courses and presumes a knowledge of the calculus in addition to general physics and chemistry. Its approach is quite a bit more rigorous, and the level of understanding in physical and organic chemistry is more akin to that studied by the chemical engineer than by the mechanical engineer.

With the increasing emphasis on engineering science in undergraduate curriculums, not only are new course patterns emerging, but also there must be new textbook approaches. It is especially interesting to note that Professor Van Vlack's text contemplates use by freshmen, instead of by third or fourth-year students to whom many materials courses traditionally have been taught. By way of antidote to the highly theoretical mathematics and science courses that the beginning student is required to study, this text becomes a sort of elementary microcosm of engineering design. The budding engineer, starting from the first day of his course, can see that something as real as a drive pinion must be made out of a material

[1] Editor, *Combustion Engineering*, Box 157, Princeton Junction, N. J. Mem. ASME.

which is capable of being formed economically as well as having the strength to withstand certain forces. After learning something of mechanical, electrical, and chemical properties, including their measurement, he proceeds to such subjects as the atomic nature of materials, metallic and ceramic phases, organic and multiphase materials, effects of microstructure and macrostructure, and behavior under service conditions, including corrosion and irradiation. This educational journey is aided by well-written explanations closely integrated with effective illustrations to which only superlatives of praise can be applied. Each of the 15 chapters is followed by a series of problems, to half of which answers are given, and by an extremely valuable list of annotated references for further reading.

If one accepts the premise that the materials course properly belongs at about the junior level, then Professor Jastrzebski's text fulfills the need for subject matter that is linked closely to mathematical and science sophistication of third-year students. Gone are the empirical and descriptive approaches found in many textbooks long established in this field. The student immediately plunges into modern physics in terms of the fundamental structure of matter, and there follows a chapter on colloids and organic high polymers in which knowledge of physical and organic chemistry would be helpful. Before completing the text the student will have encountered partial differential equations, Gibbs phase rule, stoichiometry, and semiconductors.

Many of the topics covered are similar to those in the Van Vlack text, but the treatment is consistently more advanced: Phase transformations, metallic and ceramic materials, mechanical and electrical properties, corrosion, lubrication, and cementing and protective materials. The quality of illustrations is believed to be above the usual textbook average, and each chapter includes a list of selected references, though unaccompanied by critical comments. The author has done an outstanding job of defining terms, many of which are not in common use but which nevertheless should be understood by engineers.

These two texts illustrate a point made by Prof. K. B. Woods of Purdue University in his introduction to the ASTM-ASEE Symposium, namely, that there is little uniformity in course content and methods of teaching undergraduate materials. On the other hand, it might be said that the differences between the two texts are indicative of the vitality of emerging engineering curriculums. Professor Van Vlack, for example, recognizes that the rigorous approach to the science of materials may not be necessary for engineers engaged in design and operation, although it most certainly will be required for those who may later engage in the development of new materials. Although it may be unfair to characterize it as such, Professor Jastrzebski's text has a close kinship to the educational philosophy that places more stress on theoretical engineering science than on applied engineering design.

Where does all of this leave the practicing engineer? He would do well to read the Symposium and see how the industrial and educational viewpoints merge, especially in the papers by F. L. La Que, vice-president of ASTM; Dean W. T. Alexander, then president of ASEE; Melvin F. Wood, chief engineer of du Pont; and Glenn B. Warren, immediate past-president of ASME. Incidentally, Dean Alexander cites Professor Van Vlack's book as the only one he has yet seen which is consistent with the realities of the engineering educational situation, although in fairness it must be added that the other text was not published until after the Symposium. Mr. Warren speaks for many in industry in stating that the design engineer needs materials (1) to increase reliability or life of existing designs, (2) to permit an increase in the parameters of these designs, (3) to effect reduced costs, and (4) to permit innovations in as yet unexplored technical fields. His concluding remarks are a plea to the undergraduate engineer to learn that education is a never-ending process.

Returning to the two texts, the student engineer who studies either under the direction of a sympathetic and foresighted professor will have established a base for future growth in both the science and application of engineering materials.

BOOKS RECEIVED IN LIBRARY

Vistas in Astronautics, Vol. 2

Edited by Morton Alperin and Hollingsworth F. Gregory. 1959, Pergamon Press, New York, N. Y. 318 p., $7^1/_2 \times 9^3/_4$ in., bound. $15. These papers which were presented at the Second Astronautics Symposium, survey and evaluate the progress made toward the solution of the myriad problems related to extra-atmospheric research. The areas discussed include space environment and vacuum research; control and propulsion of vehicles outside the atmosphere; departure, space navigation, and re-entry problems; and the earth's moon. Those areas which should be emphasized to facilitate future space exploration are indicated.

Absperrorgane in Rohrleitungen

By Walter Volk. 1959, Springer-Verlag, Berlin, Germany. 178 p., $6^1/_2 \times 9^1/_2$ in., bound. 25.50 DM. A survey of the valve field for the designer of fittings, the student, and the general designer of pipelines and installations, giving examples of various types of valves and discussing their characteristics and operation, as well as hydraulic fundamentals. There are special chapters for each type of valve: gate valves, sliding cylindrical valves, throttle valves, check valves, air inlet and exhaust valves, etc.

Allgemeine Schalentheorie und Ihre Anwendung in der Technik

By W. S. Wlassow. 1958, Akademie-Verlag, Berlin, Germany. 661 p., $6^3/_4 \times 9^1/_2$ in., bound. DM 75.00. A German translation from the Russian on the general theory of shells and its technical application. Part one of the monograph deals with the diaphragm theory of shells; part two presents the general bending theory of shells; in part three the author develops the bending theory of slightly bent shells; part four contains the theory of orthotropic circular cylindrical shells; part five deals with thin prismatic structures. There is a bibliography of mainly Russian references.

Atomic Energy in the Soviet Union

By Arnold Kramish. 1959, Stanford University Press, Stanford, Calif. 232 p., $5^3/_4 \times 9^1/_4$ in., bound. $4.75. Although the United States and Great Britain have both published complete reports on the development of their atomic energy program, Soviet Russia has never done so. This book is an attempt to fill the gap by providing an over-all review of the history, present scope, and future possibilities of Soviet nuclear research and development. The information which forms the basis for this book was obtained by systematically scanning many thousands of Soviet newspapers and technical journals, and represents as complete a picture of the situation as is available now currently.

Automatic Teaching

Edited by Eugene Galanter. 1959, John Wiley & Sons, Inc., New York, N. Y. 198 p., $6 \times 9^1/_2$ in., bound. $3.25. This is one of the first books to record and evaluate the methods associated with the newly developed field of machine teaching. It is based on a collection of 16 papers given at a symposium held at the University of Pennsylvania under the auspices of the United States Air Force. The various aspects of machine teaching dealt with include programming, analysis machine design, experimental results, and criticism.

Chemical Process Principles: Part 2, Thermodynamics

By Olaf A. Hougen and others. Second Edition. 1959, John Wiley & Sons, Inc., New York, N. Y. 1072 p., $6 \times 9^1/_2$ in., bound. $9.75. The fundamental principles of thermodynamics are presented with particular attention to generalized methods. In this

volume the material contained has been revised to reflect recent technological advances dealing with such aspects as improved generalized tables of state and thermodynamic properties, thermodynamics of fluid flow including the cases of compressible fluids at sub- and supersonic velocities, detailed cycle analysis of modern vapor turbine-power units, and cycle analyses of modern internal-combustion engines including free-piston gas turbine, turbojet, ramjet, and rocket engines.

Digital Computer Primer

By Edward Mack McCormick. 1959, McGraw-Hill Book Company, Inc., New York, N. Y. 214 p., $6^1/_4 \times 9^1/_4$ in., bound. $7.50. The basic principles of digital computers are presented in nonmathematical terms. Following a review of basic terminology and sequence of operations, a detailed description is given of coding, number systems, logic of computers, and the control, arithmetic, storage, and input-output units. Instructions, programming, and methods of checking accuracy are also discussed. An appendix provides material on the value of representing logical operations by means of Boolean algebra and the basic manipulations possible.

Encyclopedic Dictionary of Electronics and Nuclear Engineering

By Robert I. Sarbacher. 1959, Prentice-Hall, Inc., Englewood Cliffs, N. J. 1417 p., $7^1/_2 \times 10$ in., bound. $35. An extensive work that defines terms and provides descriptions and diagrams of equipment, components, and systems employed in electronics and nuclear engineering. Additional definitions are provided for terms in such closely related fields as electricity, physics, chemistry, and acoustics, particularly where they have a bearing on electronic and nuclear applications. Extensive cross-referencing is provided so that related entries may be studied and compared.

Foundations of Aerodynamics

By A. M. Kuethe and J. D. Schetzer. Second Edition. 1959, John Wiley & Sons, Inc., New York, N. Y. 466 p., $6 \times 9^1/_4$ in., bound. $11.75. The fundamentals of perfect, compressible, and viscous flows is presented. In general, specific technical applications are not treated except as illustrations of the underlying principles. In this edition, the chapter on energy relations has been rewritten, and the treatment of one-dimensional compressible flows has now been expanded to include sections on heat addition. The material on wings in compressible flow is presented now from the viewpoint of lifting surface theory, while the material on viscous flow includes an expanded discussion of compressibility in both laminar and turbulent flow.

Foundry Engineering

By Howard F. Taylor, and others. 1959, John Wiley & Sons, Inc., New York, N. Y. 407 p., $5^3/_4 \times 9$ in., bound. $9.75. A comprehensive approach to the engineering principles and methods of foundry operation is presented. Up-to-date coverage is given for such topics as refractories, casting processes, sand reclamation and control, welding, and heat-treatment. A feature of the book is the treatments of solidification and structure of cast metals, and of correct gating and risering of castings. Numerous three-dimensional drawings help to clarify the text.

The Grinding Wheel

By Kenneth B. Lewis. Revised Edition. 1959, The Grinding Wheel Institute, Cleveland, Ohio. 527 p., $6 \times 9^1/_4$ in., bound. $4.95. Grinding wheels, grinding machines, and grinding operations are discussed from a practical standpoint in this revised edition which contains over 100 pages of new material. Starting with abrasive materials, wheel shapes and sizes, bonds and wheel manufacture, this manual continues with the entire range of abrasive operations, covering not only metalworking, but also the grinding of ceramics, glass, marble, and concrete. Special chapters are devoted to evaluation of surface quality, truing and dressing, grinding fluids, and factors affecting wheel selection.

Handbook of Automation, Computation, and Control, Vol. 2

Edited by Eugene M. Grabbe and others. 1959, John Wiley & Sons, Inc., New York, N. Y. Various pagings, $6 \times 9^1/_4$ in., bound. $17.50. The second of three volumes, this volume provides a comprehensive coverage of the design and use of analog and digital computers and data processors. Some of the features of this handbook are chapters which deal with computer terminology, magnetic core and transistor circuits, advanced programming, and unusual computer systems involving operational digital techniques, combined analog-digital computer systems, and truing-type computers.

Integration and Competition in the Petroleum Industry

By Melvin G. de Chazeau and Alfred E. Kahn. 1959, Yale University Press., New Haven, Conn. 598 p., $6^1/_4 \times 9^1/_2$ in., bound. $7.50. An attempt is made to assess the effect of the large size and integrated structure of the major firms in the United States petroleum industry upon competition at various levels within the industry. In addition, the extreme degree of integration within the petroleum industry is explained in terms of its technology and of its historical background. It is concluded that the economic factors creating vertical integration have tended to decline, particularly in the areas of retail distribution and production.

Introduction to Nuclear Power Costs

By Arnold Rochman. 1959, Simmons-Boardman Publishing Corp., New York, N. Y. 50 p., $5^1/_2 \times 8^1/_2$ in., paper. $5. Some of the factors which make up the total cost of nuclear power are analyzed, and it is shown how variations in their value may affect the over-all cost structure. The costs of the various factors related to nuclear fuels are first analyzed, and then the factors related to the capital structure, plant, and equipment.

A New Method in the Theory of Superconductivity

By N. N. Bogoliubov, and others. 1959, Consultants Bureau, Inc., New York, N. Y. 121 p., $6 \times 9^1/_2$ in., bound. $5.75. In this translation from the Russian, a microscopic theory of superconductivity is developed on the basis of a physical and mathematical analogy with superfluidity. Calculations are given for the energy of the superconducting ground state using Fröhlich's Hamiltonian, as well as for the one-fermion and collective elementary excited states. A detailed analysis of the role of the Coulomb interaction between the electrons in the theory of superconductivity is then presented. It is then demonstrated how a system of fermions is treated with a fourth-order interaction Hamiltonian and a criterion for its superconductivity is established.

Operations Research; An Annotated Bibliography

By James H. Batchelor. Second Edition. 1959, Saint Louis University Press, St. Louis, Mo. 865 p., $5^1/_2 \times 8^3/_4$ in., bound. $10. The rapidly growing literature of operations research is extensively covered in this bibliography which includes 4195 abstracts of books and articles published up to the end of 1957. The abstracts are arranged by author, with a subject and title index to facilitate access to the items included. The material included has been confined to operations research as such, and does not include related specialties such as linear programming, cybernetics, etc.

Product Engineering Design Manual

Edited by Douglas C. Greenwood. 1959, McGraw-Hill Book Company, Inc., New York, N. Y. 342 p., $8^3/_4 \times 11^1/_4$ in., bound. $9. Drawn from articles that have appeared in *Product Engineering*, this manual consists of over 100 product design topics, each supplemented by illustrations of mechanisms, charts, formulas, and tables. Included are sections on accessories, assembly, clutches, couplings, bearings and mounts, control and measurement devices, drives, electrical and magnetic components, mechanical movements and linkages, shaft seals, springs, and welding and brazing.

Theory of Plates and Shells

By S. Timoshenko and S. Woinowsky-Krieger. Second Edition. 1959, McGraw-Hill Book Company, Inc., New York, N. Y. 580 p., $6^1/_2 \times 9^1/_2$ in., bound. $15. A thorough revision of a monograph which discusses the deformation of bodies in which one dimension (the thickness of a plate or shell) can be considered as small in comparison with the other dimensions. This edition has added a new section on the deflection of plates owing to the transverse shear, and a special chapter on the bending of anisotropic plates. The chapter on nonlinear bending of plates is enlarged considerably, while the three chapters on shell theory now include the use of Pucher's stress function, and outline the design of cylindrical roof shells. In addition, there are numerous changes and expansions throughout the text.

Turbulence

By J. O. Hinze. 1959, McGraw-Hill Book Company, Inc. New York, N. Y. 586 p., $6^1/_2 \times 9^1/_2$ in., bound. $15. The current concepts and theories relating to turbulent fluid flow are presented in such a fashion as to form a basis for advanced studies in this field. The author begins with a general introduction to turbulence theories and derives the basic formulas used. This is followed by a description of the methods and instruments used in measuring turbulence qualities, of the generally accepted theories of isotropic turbulence, and of attempts to arrive at a statistical theory of nonisotropic turbulence. An extensive study of transport properties is then followed by nonisotropic free turbulence and turbulent flow along fixed walls.

Advanced Propulsion Systems

Edited by Morton Alperin and George P. Sutton. 1959, Pergamon Press, New York, N. Y. 237 p., 7×10 in., bound. $6. This volume embodies the important results of three years of research aimed at establishing the fundamental principles of propulsion for space vehicles. Consisting of unclassified and recently declassified papers presented at the First Advanced Propulsion Systems Symposium, 1957, it presents new concepts of physical propulsion, power sources and propellants, hardware, and human hazards of space flight.

American Power Conference, Proceedings, 1959

Published by the Illinois Institute of Technology, Technology Center, Chicago, Ill.

776 p., 6 1/2 × 9 1/2 in., bound. $8. These papers give practical information of broad over-all interest to those concerned with the generation, transmission, or utilization of power. The book is divided into sections dealing with topics of general interest; nuclear energy; electrical, mechanical, and water technology. The papers in each of these areas cover technical, economic, and industrial aspects. They are written by people connected with universities and societies, industries and government, laboratories and utilities.

ASTM Manual for Rating Diesel Fuels by the Cetane Method

Published 1959 by the American Society for Testing Materials, Philadelphia, Pa. 132 p., 6 × 9 in., bound. $8.50. This manual has the two-fold purpose of revising and bringing up to date the ASTM Cetane Method D613, and of serving users of ASTM ignition-quality rating engines by providing detailed information and data on the operation and maintenance of the rating equipment.

ASTM Standards on Textile Materials

Published 1959 by the American Society for Testing Materials, Philadelphia, Pa. 902 p., 6 1/2 × 9 1/2 in., bound. $8.50. These standards include terms, definitions, methods of testing, tolerances, and specifications for fabrics, including tire cord, asbestos textiles, bast and leaf fiber textiles, glass textiles, man-made fiber textiles, and nonwoven fabrics. The appendixes contain additional information, proposed methods of testing, and tables on the properties of fibers.

Automating the Manufacturing Process

By George F. Hawley. 1959, Reinhold Publishing Corp., New York, N. Y. 147 p., 6 1/4 × 9 1/4 in., bound. $4.95. The author presents in practical terms some of the mechanical problems involved in inventing and designing machinery for specific operations, such as assembly of components, packaging individual products, bottle capping, and feeding. He sketches the background of economic feasibility for a project, describes the roles of the inventor, design engineer, and production planner in the processes of devising, modeling, building, and running the automatic machine.

Bauelemente der Feinmechanik

By O. Richter and R. v. Voss. Eighth edition, edited by F. Kozer. 1959, Verlag Technik, Berlin, Germany. 551 p., 7 × 9 1/4 in., bound. 22 DM. This new edition of a study on structural elements of instruments and other fine mechanisms attempts a systematic compilation of the knowledge in the field. Special attention is devoted to aid in technical education. The book is divided into nine sections: Connections, bearings, gears, couplings, speed regulators, etc.—with numerous subsections, designated by numbers in accordance with DIN 1421. There is a bibliography.

Berechnung von Gusseisernen Emaillierten Druckbehältern. Bond 7

By Günther Matz and Peter Gayer. 1959, Springer-Verlag, Berlin, Germany. 224 p., 6 1/2 × 9 1/2 in., bound. 37.50 DM. Deals with the design and calculations of enameled cast-iron pressure vessels, including measurements on a 6 cu-meter agitator vessel. One aim of this book is to determine from the stresses and strains arising in the enamel, reasons for spalling. Topics dealt with include measurement procedures, the significance of the most important material strength values for the determination of stresses, the evaluation of strain coefficients, and shell-theory calculations.

LIBRARY SERVICES

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Engineering Manufacturing Methods

By Gilbert S. Schaller. Second Edition. 1959, McGraw-Hill Book Company, Inc., New York, N. Y. 682 p., 6 1/2 × 9 1/2 in., bound. $9.50. Progressive concepts in manufacturing are presented in this new edition, based on research and scientific achievements which indicate the direction as well as the pace of manufacturing development. Concerned chiefly with metals, the five main sections deal with the materials of manufacturing, foundry practice, forming and heat-treating processes, machining operations, and welding. Recent advances are emphasized, including high-temperature materials, flame bending, inert gas welding, etc.

International Symposium on Plastics Testing and Standardization

Published 1959 by the American Society for Testing Materials as Special Technical Publication No. 247, Philadelphia, Pa. 276 p., 6 × 9 in., bound. $6. A collection of papers, divided into four sections, dealing with the achievement of national standards. The engineering properties of plastics, the thermal properties of plastics, and molecular characterization.

An Introduction to the Mechanics of Solids

Edited by Stephen H. Crandall and Norman C. Dahl. 1959, McGraw-Hill Book Company, Inc., New York, N. Y. 444 p., 6 1/2 × 9 1/2 in., bound. $8.50. The mechanics of rigid and deformable solids in equilibrium are discussed. In order to treat the subject as an engineering science, three fundamental physical considerations which govern the mechanics of solids in equilibrium are identified, and all discussion and theoretical development are related to them. These considerations include the study of forces, the study of deformation, and the connection of forces to deformation by approximate force-deformation relations. In addition, emphasis is placed upon the process of constructing idealized models to represent actual physical situations.

Engineering Economics for Professional Engineers' Examinations

By Max Kurtz. 1959, McGraw-Hill Book Company, New York, N. Y. 261 p., 5 1/2 × 8 1/2 in., bound. $6.50. The various aspects of engineering economics are reviewed in this text which discusses the media of investment, the time value of money, sinking funds and annuities, valuation of bonds, depreciation and depletion, annual costs, analysis of variable costs, and the legal and business phases of the construction industry. A practical feature is the inclusion of many exercises and problems which illustrate typical questions asked in PE examinations throughout the country.

Hydraulische Pressen, Vol. 3

By Ernst Müller. 1959, Springer-Verlag, Berlin, Germany. 256 p., 6 1/2 × 9 1/4 in., bound. 43.50 DM. This third volume of a German treatise on hydraulic presses and installations deals with extrusion presses for the manufacture of metal tubes and cables. It reviews the design, working elements, and operation of such presses, as well as the recent processes based on modern practice. There are special chapters on presses for the production of lead tubes and cables, presses for the production of lead and aluminum cable sheath, and on practical construction details.

Internal Stresses and Fatigue in Metals

Edited by Gerald M. Rassweiler and William L. Grube. D. Van Nostrand, Inc., Princeton, N. J. 451 p., 6 3/4 × 9 3/4 in., bound. $11. The papers included in this volume consider and interrelate the phenomena of internal stresses and fatigue in metals both from the atomistic approach of solid-state physics and the phenomenological approach used successfully in the design of cyclically stressed components. The arrangement of the papers is such that they begin with a consideration of internal stresses, continue with studies of lattice strains and defects, and conclude with studies of fatigue and its relation to stresses. The volume constitutes the proceedings of a symposium sponsored by General Motors Research Laboratories in 1958.

Introduction to Rocket Technology

By V. I. Feodosiev and G. B. Siniarev. 1959, Academic Press, Inc., New York, N. Y. 344 p., 6 1/4 × 9 1/4 in., bound. $9.50. In this book translated from the Russian, the authors undertake to introduce the reader to the general subject of rocket technology, which must unite many diversified and specialized, but, nonetheless, interdependent disciplines. Types of jet aircraft, types of reaction motors, rocket-motor fuels, processes in a combustion chamber, flow of combustion products, flight and trajectory, launching and steering all are dealt with. A general background in physics and chemistry is needed, but highly specialized areas of thermodynamics are not involved. Although some military aspects must necessarily be considered, military uses of rockets and rocket artillery are not discussed as such.

Isambard Kingdom Brunel

By L. T. C. Rolt. 1959, St. Martin's Press, New York, N. Y. 345 p., 6 × 9 in., bound. $6. This biography of one of the great engineers of the nineteenth century covers the dramatic and sometimes tragic pioneering events of his life. The building of the Great Western Railway, the first transatlantic steamship crossings, the atmospheric railway fiasco, the construction of the Saltash Bridge, the conflict between Brunel and John Scott Russell, and the final tragedy of the Great Eastern are among the happenings described. These historical events of the Industrial Revolution are made more memorable by the portrayal of the magnetic personality of Brunel himself.

Maschinenfundamente

By E. Rausch. Third Edition. 1959, VDI-Verlag GmbH., Düsseldorf, Germany. 857 p., 6 × 8 1/2 in., bound. 126 DM. An extensive treatise on machinery foundation and other dynamically loaded structures. This new edition deals more extensively with fatigue of materials, effect of damping, determination of vibration amplitudes, and discussion of their effect on people, material, and machines.

New examples and data on damage are included and new standards are considered. There is a comprehensive bibliography up to 1958.

Practical Ironmaking

By G. D. Elliot and J. A. Bond. 1959, The United Steel Companies Ltd., Sheffield, England. 276 p., $6^1/_2 \times 9^1/_2$ in., bound. $6. The operating principles of an ironworks are presented in a manner suitable both for the man who makes his living in that field and for students. The greater part of the book is written around experience in one ironworks, but it is believed that the underlying principles apply to all plants and practices. The design, maintenance, and operating procedures of a furnace, with some explanation of the theory and certain modifications of orthodox operation comprise most of the book. The preparation of ores, blast furnace slags, and the distribution of elements are among the other topics discussed.

Solid Propellent and Exothermic Compositions

By James Taylor. 1959, Interscience Publishers, Inc., New York, N. Y. 153 p., $5^1/_2 \times 8^3/_4$ in., bound. $4.25. Chemicals as a source of energy for rockets and explosives is the subject of this book, which is primarily concerned with reactions in the solid state. The range of newly developed chemical compositions and their various applications is surveyed. Among the topics discussed are propellants, explosives, low-temperature gas-producing reactions, ammonium nitrate, guanidine nitrate, solid charges, and gasless reactions. The emphasis is upon technical applications rather than the scientific background.

Symposium on Basic Research

Edited by Dael Wolfle. 1959, American Association for the Advancement of Science, Washington, D. C. 308 p., $6^1/_4 \times 9^1/_4$ in., bound. $3. Various reviews of the concepts and implications of basic research in general are followed by discussions of the relationship of basic research to the liberal arts college, the state university, and the private university. This is then followed by studies of its relationship to government and industrial laboratories as well as private research institutes. Concluding sections cover the available means of securing financial assistance.

Techniques of Plant Maintenance and Engineering, Vol. 10

Published 1959 by Clapp and Poliak, Inc., New York, N. Y. 266 p., 8 × 11 in., bound. $10. The paper presented at the 1959 National Plant Maintenance and Engineering Show provide a permanent record of advances in the field to date, and cover a broad range of subjects from the over-all organization of the plant engineering and maintenance functions to such newer developments as numerically controlled machine tools and maintenance work in nuclear plants. The papers included cover safety, labor relations, training, scheduling, and many aspects of maintenance. The book concludes with round-table discussions on individual types of plants based on practical experience.

The Theory of Thin Shells

By V. V. Novozhilov. 1959, P. Noordhoff Ltd., Groningen, The Netherlands. 376 p., $6^3/_4 \times 9^1/_2$ in., paper. $9.50. This translation from the Russian presents an analysis of stresses and deformations in shells, treated as a linear problem with displacements assumed to be small in comparison with the thickness of the shell and strains not to exceed the limit of proportionality. The four chapters treat the general theory of thin shells, the membrane theory, analysis of cylindrical shells, and shells of revolution, giving a unified point of view based on a wide utilization of complex transformations.

Advance in Space Science, Vol. 1

Edited by F. I. Ordway, III. 1959, Academic Press, New York, N. Y. 412 p., $6^1/_2 \times 9^1/_2$ in., bound. $12. Embracing nearly all phases of human scientific knowledge, space science has the principal objective of manned space travel and exploration. Biastronautics—concerning human aspects of space travel—is treated here directly, in articles on manned space cabin systems, the effect of radiation on man in space, and the nutritional aspects of space flight, and indirectly in articles dealing with orbits and interplanetary trajectories, interplanetary communications, and the problem of power supply on board orbital and space vehicles. The latest revision of the Sänger system for the classification of astronautical literature is included as an appendix. The first volume of a projected annual publication.

Advances in Geophysics, Vol. 6. (Atmospheric Diffusion and Air Pollution)

Proceedings of a Symposium held at Oxford, England in 1958. Edited by H. E. Landsberg. 1959, Academic Press, Inc., New York, N. Y. 471 p., $6^1/_2 \times 9^1/_2$ in., bound. $12. The present status and future possibilities of atmospheric diffusion research are reported in this volume. General surveys of the atmospheric diffusion of pollutants and recent findings on atmospheric turbulence are followed by papers on the theory of turbulent diffusion, the diffusion of heavy or finite particles, transfer through the troposphere and stratosphere, and the effects of thermal stratification on diffusion. Pollution patterns from points and area sources are then discussed. The subject index is brief, referring only to the titles of the articles.

The American Petroleum Industry

By H. F. Williamson and A. R. Daum. 1959, Northwestern University Press, Evanston, Ill. 864 p., $6^1/_2 \times 9^1/_2$ in., bound. $7.50. The growth of the American petroleum industry from the first commercially successful oil well in 1859 to the end of the age of kerosene illumination is traced in this first part of a two volume history of the industry, sponsored by the American Petroleum Institute. The growing pains of the infant industry; the domination of the transportation, refining, and distribution of petroleum by Standard Oil Co.; and the close relationship of the expanding oil industry and its effects on living standards at home and abroad show the integral part this developing industry played in the broadening American economy. There is an extensive bibliography at the end of the book.

Annual Review of Nuclear Science, Vol. 9

Edited by Emilio Segrè, and others. 1959, Annual Reviews, Inc., Palo Alto, Calif. 625 p., $6^1/_2 \times 9$ in., bound. $7. The papers in this annual review volume cover varied aspects of nuclear science and technology, and the developments and recent experiments in these fields are described. Photodisintegration, the pion-nucleon interaction, strange particles, and Beta-radioactivity are in the area of physics; technetium and astatine chemistry and solvent extraction in radiochemical separations are the contributions in chemistry. Plasma research, electronics in nuclear research, and fast reactors are among the general papers, and there are several articles in the biological aspects of radiation.

Classification and Indexing in Science

By B. C. Vickery. Second Edition. 1959, Academic Press Inc., New York, N. Y. 235 p., $5^1/_2 \times 9$ in., bound. $6. The modern techniques of subject analysis of scientific and technical literature are discussed, with methods of constructing classification schedules for indexing, particularly "facet analysis," and the application of a notation to the schedules for card indexing. In this new edition the accounts of alphabetical and classified indexing are expanded; indexing of chemical substances is included; new American techniques and mechanisms for information retrieval, and the developments at the 1958 Washington Conference on Scientific Information are covered. The appendices trace the history of classification in the sciences, and classification schemes for soil science, astronomy, nuclear energy devices, food technology, and container manufacture are outlined.

The Corrosion and Oxidation of Metals

By U. R. Evans. 1959, St. Martin's Press, New York, N. Y. 1094 p., $6 \times 9^3/_4$ in., bound. $25. This work represents the conclusions reached by the author in his investigations into corrosion, as well as providing a summary of other experimental work which has influenced him in reaching these conclusions. The topics discussed include simple oxidation of single metals, electrochemical corrosion, soluble inhibitors, bimetallic contacts and crevice corrosion, anodic corrosion and passivation, hydrogen evolution and acid corrosion, crystallographic corrosion, and atmospheric corrosion. In addition, a number of industrial aspects relating to boilers and condensers and to various types of coatings are discussed.

Economic Control of Interconnected Systems

By L. K. Kirchmayer. 1959, John Wiley & Sons, Inc., New York, N. Y. 207 p., $6 \times 9^1/_4$ in., bound. $12.50. Deals primarily with the treatment of mathematical methods, computers, and controllers to obtain the optimum economic operation of interconnected electric utility systems, describing pioneer methods in operation applicable to all process industries. Included is discussion of important tools for the development of optimalizing computer controllers, such as theoretical and differential analyzer performance prediction methods, development of mathematical models of process, and use of advanced circuit methods.

Einführung in Die Theorie der Strömungsmaschinen

By Albert Betz. 1959, Verlag G. Braun, Karlsruhe, Germany. 272 p., $7 \times 9^3/_4$ in., bound. 31.00 DM. An introduction to the theory of "fluid-flow machines." Following the treatment of general considerations, there are comprehensive chapters on passages, straight and circular blade arrangements, and on pumps, fans, turbines, rockets, jet engines, etc. Although the emphasis is on the theoretical aspects, there is useful material for the practical designer.

Elsevier's Rubber Dictionary in Ten Languages

Compiled and arranged by The Rubber Foundation, Delft, The Netherlands. 1959, D. Van Nostrand Company, Inc., 1537 p., $6^1/_4 \times 9$ in., bound. $60. The basic alphabetic word list is in English, arranged as a double-page table with the nine foreign-language equivalents reading horizontally. Individual alphabetic lists in Dutch, French, German, Indonesian, Italian, Japanese, Portuguese, Spanish, and Swedish are keyed numerically to the English list. Laboratory, office and field terminology, and types of equipment, processes and materials common to the rubbber industry supply the 8000 entries. A fast, skeletal reference tool.

Current Engineering: Events, News, and Comment

E. S. NEWMAN
News Editor

THE ROUNDUP

Peaceful Uses of Atomic Energy Theme of 1960 Nuclear Congress

THIS year's Nuclear Congress, held at the New York Coliseum, April 4–8, was again co-ordinated by Engineers Joint Council. Well over 4000 viewed the exhibits or attended the sessions sponsored by 28 engineering and scientific organizations including ASME.

Technical Sessions

Much of this year's technical program represented a pause for breath catching, with many evaluative papers looking to the next steps in nuclear development. The numerous progress reports of other years were missing and only one major-reactor design concept was presented in the meaty program which had been held to 62 papers by the program committee headed by E. B. Gunyou of Alco.

Reactors. The new concept was Philadelphia Electric's gas-cooled reactor [45],[1] with a 40-emw prototype scheduled for operation in 1962 and preliminary design studies under way for the 150-emw or 325-emw plant to follow. Fuel-cycle costs as low as 1.5 mills per kwhr and capital costs of $250 per kwhr appear "entirely attainable" for the larger plants. The high coolant temperature—1380 F—and the 1450-psi 1000-F steam conditions will permit thermal efficiencies approaching 40 per cent. The prototype reactor will be of the solid-fuel, homogeneous type employing graphite as moderator and helium as coolant. The U-235 fuel and Th-232 fertile material will both be in the form of carbides dispersed in a portion of the moderator and enclosed in a low-permeability graphite cladding.

A comparative study of the natural-uranium, graphite-moderated, gas-cooled reactors [18] reviewed both the French and British accomplishments with this type. In all, about 5000 mw of gas-cooled nuclear power are scheduled to be in operation in the U.K. around 1966 and this will represent about 25 per cent of the total electrical consumption.

Although all-out concentration on a single type was decided against early in the U. S. program, there has been some development of the gas-cooled type. The Army has a gas-cooled-reactor program [44] in which a Mobile Low Power Plant, ML-1, will be based on the Gas Cooled Reactor Experiment, GCRE, completed in 1959, and the Gas Turbine Test Facility at Fort Belvoir. Three individually shock-mounted packages (reactor, power conversion, control) and a fourth containing connecting cables, spare parts, and other auxiliaries will have a combined weight of 37½ tons. Power developed by an 18,000-rpm turbine, in excess of that required for the compressor, will drive a 500-kva, 3600-rpm alternator through reduction gearing. The reactor cooled by nitrogen consists of 61 stainless-steel insulated pressure tubes. Water will be the moderator.

The Army's nuclear-power program of a variety of reactor types in packaged plants for stationary and portable designs was also outlined [15]. It included two barge-mounted plants designed for Navy use under the split which assigns military nuclear development for power to the Army, other than water propulsion (Navy) and air propulsion (Air Force). A BuDocks paper [16] described the Navy's interest in these, particularly the barge-mounted plants. The one designed for use first at Gaum would have extendible caissons to convert it into an offshore platform on arrival.

The future potential of water-reactor systems, which have evolved through more generations than other reactor

[1] Numbers in brackets refer to papers in the availability list, p. 107, at the end of the report.

The 1960 Nuclear Congress: A total of 62 papers were included on the technical program; more than 150 organizations had exhibits at the Atomic Exposition, including displays from Canada, France, and Switzerland. Sponsored by Engineers Joint Council, the Congress was supported by 28 engineering (including ASME) and scientific organizations. Both were held at the New York Coliseum.

Six pioneers who helped create the Atomic Age gathered April 3 on the eve of the opening of the 1960 Nuclear Congress and International Atomic Exposition in the New York Coliseum. Examining one of the Nuclear Exhibits, a new neutron generator, are, **left to right**: Dr. A. Von Grosse, **front kneeling**; Dr. Lauchlin M. Currie; Dr. E. C. Cruetz; Dr. W. H. Zinn; Dr. Clarke Williams; and Dr. John R. Dunning.

types, was considered [43]. The study gives most attention to the pressurized-water reactor although a 2000-psi open-cycle boiling-water reactor is discussed. Now in their third generation with such plants as Yankee, Dresden, and Indian Point nearly operable, specific designs are already proposed for a fourth generation, and the extensions of present technology required for a fifth generation are known. Improved economics is basic to further development. Avenues of approach for the fourth generation include: (*a*) Radial flux flattening through varying degrees of enrichment and reaching a maximum at the outside; (*b*) fuel-bearing control-rod followers used to minimize peaking in the gaps left when nonfollowed rods are withdrawn; (*c*) moderator flux control at power as a control shim and another means of reducing control-rod effects. Conservatively based on an 80 per cent plant-load factor (although 90 per cent is nearer actual conditions), the estimated fourth-generation power cost is 8.1 mills per kwhr.

An over-all cost incentive of about $^2/_3$ mill per kwhr for nuclear superheat with boiling-water reactors was indicated in another paper [46]. A separate light-water-moderated steam-cooled reactor is proposed for a 325-net-emw plant which would provide 1000-psia 1000-F steam at the throttle with a heat rate of 9400 Btu per kwhr.

Reactor development in the next ten years was summarized in an unpreprinted AEC report by Frank Pittman and U. S. Staebler of the Reactor Development Division. On the whole, it was stated, reactors are now moving into the 200-mw range. The projected date for reactors that are economically competitive in high-fuel-cost areas—defined as 35 cents or more per million Btu and 7 mills per kwhr for conventional 300-mw units—is 1968. Light-water-cooled and organic-cooled reactors are considered capable of meeting the deadline. The liquid-metal and gas-cooled reactors might achieve competitive cost by then but because of technical difficulties have been assigned to a longer-range grouping which is planned to be competitive anywhere in the U. S. The heavy-water program is being worked out in close co-operation with Canada, which has emphasized this approach. The U. S. expects to have 1400 emw on the line by 1964 with 17 plants scheduled to go critical in the next few years. The report also detailed specific research needed for each reactor type.

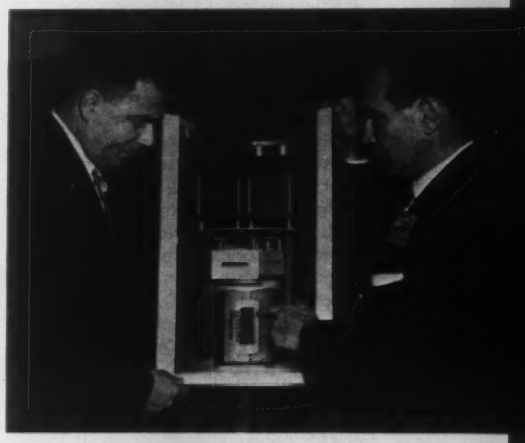
Materials and Components. The current status of the Plutonium Recycle Program, which has been supported at Hanford for the past three and a half years, was reported [26]. Development, demonstration, and optimization of the technology and economics for the use of plutonium fuels in thermal heterogeneous power reactors are the purpose. Recycling of plutonium would permit recovery of up to four times the energy currently being realized from a given quantity of uranium. The application of plutonium would permit the benefits of the use of enriched uranium without placing reliance on isotope-separation facilities and with economic benefits for all power-reactor concepts where the sale of by-product plutonium affects the net costs of power.

Experience has been obtained in the use of organic coolant [6] and the concept has been developed to a commercial reality with an 11,400-net-ekw station under construction at Piqua, Ohio. A design study for a 300-emw station was completed in 1959 and a more recent design for a 165-emw plant has low capital cost and competitive fuel cost.

Research and Radiation Facilities

A few of the uses of the Battelle research reactor [27] include a gas-cooled loop, high-temperature capsule irradiations in connection with the pebble-bed

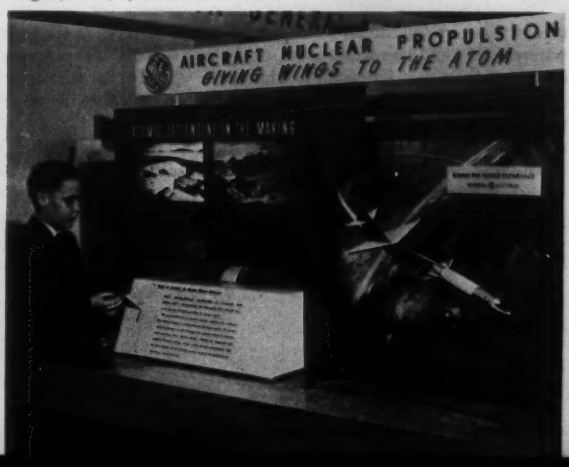
Two nuclear engineers give leak detector at French exhibit a thorough inspection



Paul Aebersold, **right,** of the U. S. Atomic Energy Commission on the exposition tour

Interested onlookers watch Hughes Mark 1 B modular Mobot handle eggs, blocks, cylindrical objects to demonstrate its versatility. And it's all done by remote control. In this building-block system modules can be combined to meet virtually any handling requirement, simple or complex. This building-block concept also means flexibility since the system can be expanded gradually by adding modules.

Model of a nuclear propulsion system for aircraft which can be operated by visitors was featured in the General Electric exhibit. This schematic representation of an actual nuclear propulsion system shows how heat from a reactor would be used to power an aircraft turbojet engine, operated on a direct air-cycle system. Fred Bucci, ten, of North Bergen, N. J., operates the model.



reactor concept, and shielding studies for aircraft nuclear propulsion. An extensive report detailed in-pile-loop experience at Oak Ridge [28]. This has included loops cooled with water, gas, single-pass air, sodium, and helium; and fuel loops of aqueous uranyl sulfate and molten salt. Safety standards, operation procedures, and checks of instrument reliability and component reliability have resulted, in addition to the basic operating information.

Plant Construction. The test equipment used in a study of plant containment, aimed at demonstrating that vapor-containment shells could be reduced materially [10], ended in such damage that "it was not practical to contemplate a future test." However, cold water in the containment would greatly reduce the pressure and the practicability of the idea was considered demonstrated.

The releases of radioactivity to the environment at Shippingport [11] have been within the limits considered safe by State and Federal authorities, and all low-level wastes generated under normal operating conditions can be released.

Instrumentation. The present needs in instrumentation and control technology were thoroughly but briefly presented in an AEC report [35]. Some of these were: (*a*) Ionization counters and chambers for neutron flux measurement in temperature environments above 570 F; (*b*) others with improved gamma compensation for intermediate power levels; (*c*) those capable of operating over 10 decades of reactor power; (*d*) miniature sensors with long life and high reliability for operating directly in the core of high-temperature reactors; (*e*) neutron sensors with output currents high enough to operate relays directly in protective channels; (*f*) sensors to increase fast-neutron flux at places where the thermal-neutron flux is depressed by control rods, coolant loops, and other neutron absorbers; (*g*) neutron sensors with self-generating voltage or current signals; (*h*) new methods for calibrating and checking the operation of sensors located in inaccessible places. It is considered particularly desirable to eliminate the "Seeing-Eye-Dog approach."

The (*d*) requirement has already been met in a design for the Dresden plant [33] where 64 $1^3/_4$-in-long, $^1/_4$-in-diam neutron-sensitive ionization chambers and 16 activation wire thimbles for periodic checking and instrumentation are used.

The basic requirements of instrumentation and control for closed-cycle water plants were described [32]. Trends in French reactor instrumentation were summarized [61] as transistorization of equipment, digitalization of information, and an increase in automation and safety measures. A fission chamber capable of working at 600 C (1112 F) has been developed, and a method of detecting can leaks—important in gas-cooled reactors—is another achievement.

Design Engineering. A method for the determination of pressure where water is in two phases—liquid and vapor—which are in equilibrium was described [56]. In the economic sphere net fuel-cycle costs were calculated for the BeO-moderated, unclad-fuel-element version of the Maritime Gas-Cooled Reactor for initial fueling with U-238 and U-235, and with Th and U-235, and the latter was found cheaper. In the clad-fuel-element version there was no cost reduction.

Natural-convection flow in liquid-metal mobile-fuel nuclear reactors [58] and hydraulic instability of reactor parallel-plate fuel assemblies [57] were other topics.

Nuclear Standards. ASTM, ANS, ASME, and ASA standards activities in the nuclear field were outlined. The recognition in 1955 that no new engineering societies were needed to deal with the special engineering problems associated with the nuclear field [62] has been borne out. Communication problems still exist in making known the areas of activity and the procedures to be followed.

ASTM is working on radiation-induced changes in materials and a handbook on dosimetry will soon be published. Existing standards for corrosion and heat-resisting alloys are being modified by attachment of optional requirements. Specifications for lead used as shielding, and nickel and nickel-based alloys have been issued, and it has been agreed that standardization of graphite for nuclear applications is desirable. A number of specifications for nonferrous metals will be issued. In the field of nondestructive testing both dry and wet magnetic-particle methods have been developed, as have radiographic standards and aluminum-alloy ultrasonic-testing standard-reference blocks. Eddy-current testing methods are being developed. Concrete for radiation shielding, radioactivity in industrial water, radiation effects on polymers, chemical analysis of reactor metals, and standards for spectrochemical analysis are other areas of interest.

ASME's Boiler and Pressure Vessel Committee [41] establishes rules of safety governing the design, fabrication, and inspection during construction of boilers and unfired pressure vessels and interprets them when questions arise. There are 16 subcommittees of the Main Committee, 10 special committees, including the Special Committee on Nuclear Power, and numerous task groups.

ASA Committee N 6 [42] which has prepared a tentative standard for the design of reactor containment is also sponsored by ASME.

Pressure reliefs, temperature controls, operating restrictions, degrees of radioactive containment by fuel cladding and other "systems engineering" studies are among the work ahead. Other pressure-containing components such as control-rod housing need attention. Knowledge of radiation effects on materials is needed for proper consideration of allowable design stresses. Each of the many new materials of construction must be given detailed consideration.

All-Congress Banquet

As principal speaker at the All-Congress Banquet, Wednesday evening, Walker L. Cisler, President ASME, gave a brief account of progress in nuclear power developments, and what we may expect in the 1960's. Mr. Cisler, who is President of the Detroit Edison Company, pointed out that the 1954 Atomic Energy Act opened the door for private companies to pursue atomic power. Currently, more than 132 electric power companies are engaged in nuclear power programs. Three plants are in operation, three more are scheduled. By the end of 1960, capacity will be about 490,000 kw. Eight more plants are also under construction, with three additional plants in the planning stage. This total of 17 nuclear plants will create 1,800,000 kw.

Substantial results can be expected in the years ahead. More restricted information has been declassified by AEC, and this procedure will continue. Mr. Cisler said that there must be good reasons for building a nuclear power plant, since this is an extremely expensive luxury. We must face facts, he said, that nuclear energy is high priced. Second and third generation plants will still be higher in cost.

The nuclear power plants must justify itself either in low cost or efficient operation. However, we need it as a research tool, to obtain experience, in which case it may be worth every dollar we expend. Most nuclear plants, he explained, can often serve as several plants. Examples: Trying out new fuels, new fuel assemblies, new cores, etc. In fact, the reactors now being built are actually large research facilities. However, it will be several years before we have a significant amount of necessary data.

There is also a need for the attainment

of reliable techniques for use of plutonium in reactors. This, he said, will be a great step forward and might lead to a low-cost fuel cycle. Dr. Clarke Williams, general chairman of the Congress, presided, and Dean John R. Dunning of the EJC Nuclear Congress Committee, acted as toastmaster.

1960 EJC Nuclear Congress Papers—Availability List

THE papers in this list are available in separate copy form until Sept. 1, 1960. Please order only by paper number, otherwise the order will be returned. Copies of these papers may be obtained from Engineers Joint Council, 29 West 39th Street, New York 18, N. Y. Papers are priced at 50 cents. Payment may be made by check or money order.

6 Experience in Use of Organic Coolant in Nuclear Reactors, by S. C. Spencer, W. N. Bley, R. W. Burkhardt, and G. O. Haroldsen

7 Low Impurity Core Materials, by D. D. Foley, G. P. Pancer, and J. L. Zegger

8 Bureau of Mines Research on the Fused Salt Electrorefining of Beryllium, by D. H. Baker, Jr., M. M. Wong, and R. E. Campbell

9 Preparation of High-Purity Thorium by Reduction With Sodium, by F. E. Block and P. C. Good

10 Results of 1959 Nuclear Power Plant Containment Tests, by Alf Kolflat

11 Review of Shippingport Operations—Site Factors, by J. E. Gray

13 Civil Engineering Aspects of Nuclear Power Plants, by R. W. Kupp and J. C. Tourek

14 Sites for Nuclear Power Plants for Large Spanish Utility, by Jamie Mac-Veigh

15 The Army Nuclear Power Program, by D. G. Williams

16 BuDocks Role in the Development of Nuclear Power for The Navy's Shore Bases, by W. J. Christensen

18 Comparative Study of the Natural Uranium Graphite Moderated Gas Cooled Reactors (U. S., British, French, and so on), by Robert Gibrat

19 Status of Regulation at the Municipal Level, by Hanson Blatz

21 Status of Regulation on Federal Level: Responsibilities of The U. S. Public Health Service, by F. J. Weber

22 Current Status of International Regulatory Activities in the Field of Public Health as Related to Atomic Energy and Its Uses in Industry, A. I. Galagan

23 Ignition and Detonation of Uranium in Bromine Trifluoride Solutions, by R. Johnson, F. Horn, and G. Strickland

24 Uranium–Thorium Reprocessing; Cost Outlook for Commercial Operation, by R. J. Klotzbach

25 Liquid–Liquid Extraction–Influence of the Physical Properties Variation of Solution Upon Pulsed Column Performance, by Xavier Talmont and Jean Durandel

26 Status of the Plutonium Re-Cycle Reactor, by R. E. Dunn

27 Operation and Experimental Use of the Battelle Research Reactor, by A. M. Plummer, J. N. Anno, and J. W. Chastain, Jr.

28 Operating Experience With In-Pile Loops at ORNL, by J. A. Cox

29 Construction and Operation of The McMaster Nuclear Reactor, by W. H. Fleming

30 The Design of a Hot Laboratory for Metallurgical Research in Germany, by W. Stephan

31 Applications of Swimming Pool Reactors, by Mrs. J. Libert

32 Basic Requirements of Instrumentation and Control for Closed-Cycle Water Nuclear Power Plants, by C. F. Obermesser

33 Control and Instrumentation Equipment In-Core, by H. M. Ogle, J. Forster, H. H. Hendon, and J. H. Keeler

35 Present Needs in Instrumentation and Control Technology for Nuclear Power Reactors, by C. Legler

37 Strontium 90 in Surface Water, by C. P. Straub, L. R. Setter, P. F. Hallbach, and A. S. Goldin

38 Continuous Calcination of Aqueous Radio-Active Waste Solutions by Radiant Heat, by R. T. Alleman and P. M. Johnson

39 Surveillance of a Municipal Water System to Assure Control of Radioisotopes—A Study of the Hanford Atomic Products Operation, by L. Junkins

41 ASME Committee on Nuclear Power of the Boiler and Pressure Vessel, by D. A. Rogers

42 ASA's Materials Task Force, Nuclear Advisory Committee, by J. A. Klapper

43 Advanced Water Reactors Systems, by W. E. Shoupp and J. H. Wright

44 Army Gas Cooled Reactors, by M. A. Rosen and G. A. Bicher

45 High-Temperature, Gas-Cooled, Graphite-Moderated Reactor (HTGR), by David Rose

46 Nuclear Superheaters for Boiling Water Reactors, by E. L. Zebroski, K. M. Horst, and P. G. Aline

47 Industrial Radioisotope Applications Development Sponsored by U. S. AEC, by G. Aebersold

48 Applications of Nuclear Science in the Producing Branch of the Petroleum Industry, by Milton Williams

49 Field Techniques and Instrumentation for Radioactive Gas Tracers, by F. E. Armstrong

50 Isotopic Power, by G. Morse

51 Low Level Tritium Measurement With the Liquid Scintillation Spectrometer, by J. Kaufman and Richard Hours

52 Progress and Problems in Radiation Processing of Foods, by Walter Urbain

53 Commercialization Technology and Economics in Radiation Processing, by F. Kraybill and D. C. Brunton

54 Radiation Technology for Non-biological Materials, by A. J. Restaino

55 Current Aspects of the Wholesomeness of Irradiated Foods, by Merrill Read

56 Determination of Pressure in a Two-Phase Water System, by W. H. Comtois

57 Hydraulic Instability of Reactor Parallel Plate Fuel Assemblies, by E. B. Johansson

58 Natural Convection Flow in Liquid-Metal Mobile Fuel Nuclear Reactors, by F. G. Hammitt and E. M. Brower

59 A Method for the Economic Comparison of The Th-U-235 Fuel Cycle Versus the U-238-U-235 Fuel Cycle With Application to the MGCR, by R. T. Shanstrom

61 Trends in the Control of Reactors in France, by Jacky Weill

62 ASTM, by G. D. Calkins

SwRI Reports on Pressure Vessel Research

IN THE early part of the nineteenth century, boilers and other forms of pressure vessels were a definite hazard, both in their operation, which was, at best, erratic, and in their predilection to explode without notice. There was a definite need for safety rules; more important, there was at the outset the lack of an organization which had the ability to write the rules and the authority to command their acceptance.

Early boilers, primarily because of a general lack of knowledge, were constructed in a multitude of strange and unusual shapes. Most of them were not stayed and had no safety devices. What kept the number of disasters resulting from explosions at a low figure was the relatively low pressure under which the boilers operated.

In the first 80 years of the nineteenth century, steam pressures increased approximately one psi per year. In 1885, when pressures of 100 psi were not uncommon, boiler explosions suddenly increased. From 1867 to 1908, some 10,000 boiler explosions resulted in over 10,000 deaths. The most notorious explosion occurred on the Mississippi steamboat, *Sultana*, in 1865. Out of a total number of 2021 persons, 1238 were killed in the explosion.

During this time, several efforts had been made to establish some type of safety control over the use of boilers. From 1830 to 1836, a Franklin Institute committee investigated the causes of steamboat boiler explosions, and concluded that the explosions were due to natural causes and not to mysterious agencies, as was believed before then.

Massachusetts passed the first legislation regarding boilers in 1849. The act required a fusible safety plug on all steam engines and boiler , but was amended in 1850 to cover boilers only. It also specified the location of the plug in the boiler.

However, public apathy restricted any definitive work toward boiler safety regulations until 1905, when a fire-tube boiler in a Brockton, Mass., shoe factory exploded. 58 persons were killed, 117 injured, and the damage was over a quarter of a million dollars. The following session of the Massachusetts legislature established a Board of Boiler Rules which was to establish regulations covering the construction and installation of boilers. This was the first safety group in the country organized by a state. By 1920, 11 other states had laws similiar to those of Massachusetts. Though the interest was definitely a step in the right direction, the laws themselves often conflicted. As a result, what was required in one state could be in direct opposition with another state's regulations. Manufacturers in particular were hard pressed by the new regulations, for they could no longer produce to stock, and operators could not move

any boilers from one state to the next.

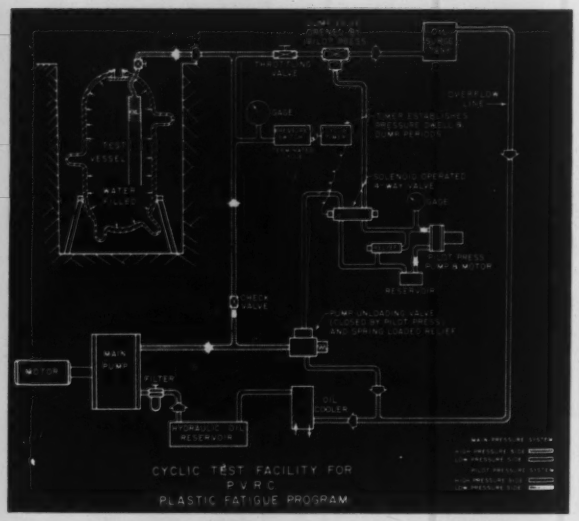
ASME Boiler Code. For some time, The American Society of Mechanical Engineers had been urged by a group of its members to write a set of boiler rules. Manufacturers and other users of boilers and pressure vessels now seconded the urging. In 1911, the ASME Council appointed a committee of seven engineers to begin work. In 1914, an advisory committee of 18 engineers was appointed to assist. Later, the two groups were merged into the Boiler Code Committee.

Three and a half years and four drafts after their appointment, the committee presented the final draft of the Code to the ASME Council in 1915. Part I of the Code dealt with power boilers; the second section with heating boilers. Part II dealt with existing installations.

The second edition of the Code was issued in 1918. In 1921, Section III on Locomotive Boilers was adopted, Section V on Miniature Boilers in 1922, and Section IV on Heating Boilers was issued in 1923. In 1924, the third edition of Section I, Power Boilers, and Section II, Materials, and Section VI, Inspection, were issued.

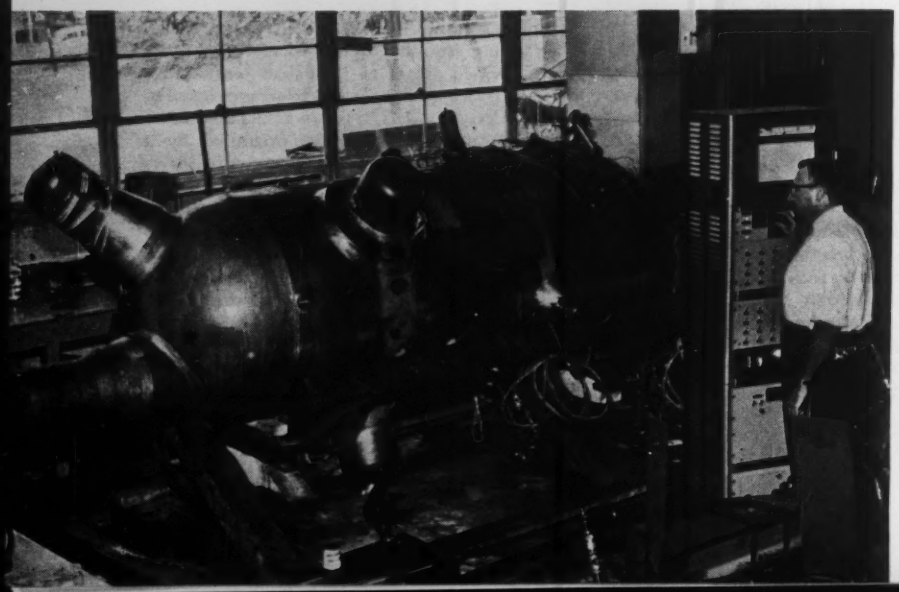
At the first meeting after the adoption of the Code, the Boiler Code Committee was granted authority to consider regulations for pressure vessels. In 1919, the Subcommittee on Air Tanks and Pressure Vessels was appointed. After six years' work, the final draft was approved in 1925, and became Section VIII, Rules for the Construction of Unfired Pressure Vessels.

About this time, fabrication methods were surveyed and rules concerning them were drawn up. Those adopted in 1925 allowed joints to be made by riveting, fusion-welding, forge-welding, and brazing. However, fusion-welding was greatly restricted.



Schematic layout of the test facility at Southwest Research Institute, San Antonio, Texas

First test pressure vessel used at SwRI's test facility. Dr. M. M. Lemcoe, project leader, is shown with the vessel.



Pressure Vessel Field. In the next decade, the pressure vessel field was the scene of considerable activity. Four editions of Section VIII dealing with Unfired Pressure Vessels were issued in five years. They dealt with the three grades of construction as well as specified regulations concerning radiographing and stress-relieving. The revised edition also reduced allowable stresses above 700 F, laid out new rules for dished and flat heads, revised the rules for openings, and included new regulations for vessels under external pressure.

While formulation and revision of the Boiler Code had been in progress several years, the petroleum industry had been using large pressure vessels at high temperatures and pressures during this time. In 1931, representatives of the American Petroleum Institute (API) and ASME met to consider an API proposal for an Unfired Pressure Vessel Code which would regulate vessels used for flammable liquids and gases. A joint committee was formed composed of representatives of API and ASME. Their purpose was to write a code which could cover the petroleum industry's problems.

The first edition of the API-ASME Code was published in 1934. It was less conservative than the ASME Code, allowing a safety factor of 4 rather than 5; allowing a joint efficiency for stress-relieved and radiographed vessels of 0.95 rather than 0.90; and requiring that vessels be stress-relieved only when the plate thickness exceeds $1\frac{1}{4}$ in., as opposed to the $1\frac{1}{2}$ in. requirement of the ASME Code.

However, though the new code was less rigid in its requirements than was the original ASME Code, there were many areas of conflict between the two. Allowable stress ratios were not constant, varying between 1.15 and 1.25. The ASME shell formulas used the inside radius for calculations, while the API-ASME shell formulas used the mean radius. Other areas in which the two codes differed included heads, stress raisers, requirements for fabrication and inspection, and qualifications for the inspector. The API-ASME Code stated that he should be employed by the purchaser or by a qualified inspection organization. The ASME Code stipulated that he would be a state, insurance company, or municipal inspector of pressure vessels.

Because of the difference in the codes, some of which led to difficulty, the Boiler Code Committee appointed a Special Committee in 1935 to revise Section VIII. After a number of preliminary drafts had been written, the final draft

was approved by the committee in 1949.

During the 14 years in which Section VIII was being rewritten, the main Boiler Code Committee had been altering the code to the extent that many differences between the two sets of rules had been eliminated.

The 1952 edition of Section VIII of the Boiler Code is in three sections. The first is concerned with general requirements applicable to all pressure vessels. The second regulates welded, riveted, forged, and brazed methods of construction. The third contains rules for materials, including carbon and low-alloy steel, nonferrous metals, high-alloy steel, cast iron, and clad and lined material.

Though the Boiler Code has undergone almost constant revision since its formulation, there are several areas in which knowledge is still limited. One of these deals with the effect cycling has on fatigue in pressure vessel material. Though much information is available on the results of millions of cycles from low pressure up to a maximum pressure, there is a paucity of data for fatigue behavior in the range of 5000 to 100,000 cycles. It is in this area that pressure vessel designers are most interested.[1]

The Pressure Vessel Research Committee of the Welding Research Council and the Reactor Division of the Atomic Energy Commission were aware of this need.

The Welding Research Council has for many years been actively concerned in the field of pressure vessels, and has sponsored many research programs on various aspects of pressure vessel fabrication. It was organized by the Engineering Foundation some 25 years ago to provide a mechanism for conducting needed co-operative research work in the welding field. Its co-operative method enables it to bring diversified talents of experts representing many branches of science and engineering to problems, thus enhancing the possibility of fundamental solutions which will be broadly applicable.

As a result, they have sponsored a three-year pressure vessel research program which began in 1958. In addition to work going on at Southwest Research Institute (SwRI), San Antonio, Texas, related studies are being carried out at École Polytechnique, Lehigh University, and at the University of Illinois.

The over-all objective of the program is to obtain a clearer understanding of the mechanisms involved in plastic fatigue behavior in large-size pressure vessels, and to develop more rational methods of stress analysis for predicting the magnitudes of the significant stresses in such vessels. This work is carried out by building experimental vessels with a variety of nozzle designs and configurations. Under a carefully controlled testing program, the vessels are subjected to varying pressures.

SwRI Research. At SwRI, work to date has included design and fabrication of the test vessels, completion of a brittle coating, and electric resistance strain gage analysis. This analysis required approximately 900 gages mounted at critical regions, such as the nozzle-to-shell and head-to-shell junctures. A fundamental study of the redistribution of plastic strain in these regions is also in progress, in addition to a correlation of the notch factors obtained from these full-size tests with those obtained on small scale model tests.

As noted earlier, the ASME Boiler Code has undergone almost constant revision since it was first written. However, overdesign resulting from safety requirements is still a problem. Most pressure vessels designed in accordance with the Code for Unfired Pressure Vessels are designed on the basis of maximum allowable working membrane stress of only $^1/_4$ the ultimate strength of the material. If design could be based on fatigue strengths rather than on ultimate strengths, engineers would have a more rational tool to deal with the problem of maximum strengths of pressure vessels.

While the over-all program includes testing identical pairs of vessels fabricated from A-201, A-302, and T-1 steels (low to high strength), the work in progress concerns only the A-201 metal.

The vessels under study at SwRI have a 36-in. inside diam, 2-in. wall thickness, and incorporate nozzles of several designs and sizes.

Static stress analysis of one of the A-201 vessels has been performed with Stresscoat to identify regions of critical strain. Stresscoat is a brittle, ceramic coating sprayed on the vessels. When it is subjected to internal pressure, the areas where the coating has cracked identify the points of greatest strain, thus pointing the way for intensive testing of those areas.

Following the Stresscoat testing, a strain analysis is performed to measure the critical strains and stresses resulting from internal pressure.

It was noted that one of the areas of limited knowledge lies where vessels have been cycled between 20,000 and 100,000 times. At SwRI, after the strain analysis is completed, fatigue testing will be carried out on both vessels. One vessel will be cycled to a peak pressure of approximately 4500 psi for 20,000 times or until it ruptures. The other vessel of the pair will be tested under a lower cyclic pressure of 2500 psi selected to cause failure in approximately 100,000 cycles.

One of the most complete pressure-testing and cycling installations in the United States is at SwRI. Test vessels ranging in size and weight up to six tons can be subjected to evaluation. The cycling facility permits pressures on the order of 10,000 psi, at a cycling rate of one to three per minute, depending on the peak pressure required.

To power the hydraulic testing system, a variable displacement, pressure-compensated pump is used to supply the primary 2000 psi oil-control system. Downstream from the pump is an adjustable relief valve which limits maximum pressure in the system. The pump furnishes oil to a double-acting five-to-one booster which is reversed at the end of its stroke by contacting a limit switch, which actuates a 4-way solenoid valve. The solenoid controls the pilot oil to throw a 4-way valve and reverses the direction of the pressure oil going to the low-pressure side of the booster. The plunger ends of the booster force water through check valves into a manifold and then directly into the pressure vessel being cycled.

Maximum pressure per cycle is determined by setting a pressure switch. The time of holding peak pressure is determined by a time delay relay. At the end of a given period, the relay will actuate a solenoid-controlled pilot-operated 4-way valve which opens a 10,000-psi valve and admits water from the pressure vessel through a choke back to the water reservoir.

Strain-concentration factors determined in the static-stress analysis, initial cycling, and results of plastic fatigue tests will be correlated with results of related studies at the other laboratories engaged in pressure vessel investigation.

Before the vessels were tested, the theoretical circular and longitudinal membrane stresses were computed and were found to be in close agreement. The outside measured stress agreed with the theoretical one within 2 per cent, while the inside measured stress agreed with the theoretical value within 1 per cent.

Phase II of the project, already under way, will include subjecting the test vessel to an initial cycling to determine the possible redistribution of stress or strain. Initial cycling will be limited to 100 cycles. In this fashion, the stresses and strains may be "shaken down" to a

[1] Dolan, T. J., "Fatigue as a Factor in Pressure Vessel Design," *The Welding Journal Research Supplement*, June, 1954.

more realistic level—one which will conform with design.

After the initial test, the vessel will be cycled at 5000 psi to produce failure in approximately 20,000 cycles at the most critical point.

From the present research program, valuable information may be contributed to tie the "loose ends" of knowledge. With the results of this program, Section VIII of the ASME Boiler Code may open the way for the use of new metals.

References

Bergman, E. O., "The ASME Pressure Vessel Code: A Joint Effort for Safe Construction," ASME, September, 1953.

Dolan, T. J., "Fatigue as a Factor in Pressure Vessel Design," *The Welding Journal Research Supplement*, June, 1954.

Kooistra, L. F., "Effect of Plastic Fatigue on Pressure-Vessel Materials and Design," *The Welding Journal*, March, 1957.

MEETINGS OF OTHER SOCIETIES

May 15–19

Institute of Food Technologists, 20th annual meeting, San Francisco, Calif.

May 16–18

American Management Association, forum on simulation and business games, AMA Academy, New York, N. Y.

May 17–20

Verein Deutscher Ingenieure, annual meeting, Hamburg, Germany

May 18–20

Society for Experimental Stress Analysis, spring meeting, Hotel Severin, Indianapolis, Ind.

May 19–20

Society of American Military Engineers, national convention, Washington, D. C.

May 19–20

Operations Research Society of America, annual meeting, Statler Hotel, New York, N. Y.

May 22–26

NOMA, 41st international conference and office exposition, Queen Elizabeth Hotel and Show Mart, Montreal, Que., Canada

May 23–25

National Telemetering Conference, Miramar Hotel, Santa Monica, Calif.

May 24–26

American Society for Quality Control, annual convention, Sheraton-Palace Hotel, San Francisco, Calif.

May 26–27

AIME, 14th annual New England regional conference, Statler Hilton Hotel, Boston, Mass.

May 26–28

SNAME, spring meeting, Statler Hilton Hotel, Washington, D. C.

May 29–June 11

The Iron and Steel Institute, special meeting, Milan, Italy

June 1–3

Instrument Society of America, annual instrumental methods of analysis symposium, Montreal, Que., Canada

June 5–9

SPI, national conference, Commodore Hotel; ninth national plastics exposition, Coliseum, New York, N. Y.

June 5–9

World Power Conference, sectional meeting on methods for solving power shortage problems, Madrid, Spain

June 5–10

SAE, summer meeting, Edgewater Beach Hotel, Chicago, Ill.

June 6–8

Edison Electric Institute, annual convention, Atlantic City, N. J.

June 8–11

NSPE, annual meeting, Statler Hotel, Boston, Mass.

June 12–15

American Society of Agricultural Engineers, annual meeting, Ohio State University, Columbus, Ohio

June 12–16

American Nuclear Society, sixth annual meeting, Palmer House, Chicago, Ill.

June 12–16

International Union of Pure and Applied Physics, Utrecht, The Netherlands

June 12–18

International Institute of Welding, assembly, Brussels, Belgium

June 13–15

AIME, international powder metallurgy conference, Hotel Biltmore, New York, N. Y.

June 13–15

ASHRAE, annual meeting, Vancouver, B. C., Canada

June 13–17

ASCE, conference on shear strength of cohesive soils, University of Colorado, Boulder, Colo.

June 13–18

International Organization for Standardization, ISO/TC 77 (products in asbestos cement), Stockholm, Sweden

June 15–17

Heat Transfer and Fluid Mechanics Institute, Stanford University, Stanford, Calif.

June 15–25

CIGRÉ, international conference on large electric systems, Paris, France

(For ASME Coming Events see page 130.)

CIGRÉ to Be Held in Paris, June 15–25

SEVENTEEN U. S. engineers representing electric utilities and electrical manufacturing firms will author eight of the 130 technical papers on electric power generation and transmission that will be presented at the 18th biennial meeting of the International Conference on Large Electric Systems to be held in Paris, France, June 15 to 25, 1960.

The papers are sponsored by the U. S. National Committee, a group of 19 leading authorities in power system engineering, who guide and direct United States participation in this oldest and largest of international organizations for interchange of engineering information among nations.

Known among engineers as CIGRÉ, the initials of its French name—Conference Internationale Des Grands Reseaux Électriques—the Paris-based conference was founded in March, 1921, to study advances in the engineering of large high-voltage electric systems; it now has more than 2400 members from 50 countries; 314 from the United States.

The 130 papers to be presented at the 1960 Paris conference fall into four general groups. Section 1, Generation, transformation, and circuit interruption; Section 2, Construction, insulation, and maintenance of overhead and underground lines; Section 3, Operation, protection, and interconnection of power systems; and Section 4, Power transmission at voltages over 220 kv.

In the program for the Paris conference, papers by U. S. engineers will present important new developments in American high voltage transmission practice. Among them will be reports on the 345-kv transmission system of the American Electric Power Co. and Ohio Valley Electric Co., details of the 750-kv "Project EHV" research program of General Electric Company in Western Massachusetts, as well as a paper by engineers of Consolidated Edison Co. of

New York on protection of turbine generators. Other U. S. authors will discuss planning of large power systems, the design and testing of transformers and circuit breakers, as well as the application of insulators to high voltage lines.

Included among the presentations by U. S. power experts will be reports by Americans who are chairmen of two of the 18 CIGRÉ's International Study Committees. These committees co-ordinate the collection of specialized technical information among member countries and are made up of outstanding international authorities in each specialized field. The U. S. has 17 representatives and 76 advisers on 17 of CIGRÉ's 18 Study Committees in addition to the two chairmen.

Selection of the subjects and authors of technical papers to be offered by U. S. members of CIGRÉ at the 1960 Paris conference was made by the six-man U. S. Technical Subcommittee under the direction of C. W. Franklin, consulting electrical engineer, Consolidated Edison Co. of New York, Inc.

Officers of the U. S. National Committee are: President, Philip Sporn, Hon. Mem. ASME, president, American Electric Power Company; Vice-President, C. W. Franklin, consulting electrical engineer, Consolidated Edison Co. of New York, Inc.; Secretary-Treasurer, W. S. Price, research engineer, American Electric Power Service Corp.

All delegates to the CIGRÉ conference are required to register through the U. S. National Committee. Registration forms, obtainable from the Committee, must be returned with the registration fee ($50 for permanent members, $62 for nonmembers) to the Secretary, U. S. National Committee—CIGRÉ, 2 Broadway, New York 8, N. Y. English language translations of technical papers are distributed in advance of the Paris conference to all registered delegates as well as to permanent members of CIGRÉ.

Technical sessions of the Paris conference will be held at Fondation Berthelot, 28 bis, rue Saint-Dominique, close to the Assemblée Nationale. There will be 23 technical and three general sessions during the ten-day conference.

Nondestructive Testing

THE Atomic Energy Commission will conduct an unclassified symposium on nondestructive testing of reactor materials at their headquarters in Germantown, Md., May 20, to acquaint industry with the latest equipment and techniques.

Mechanical Exhibit

A MECHANICAL EXHIBIT to be held May 9–June 4 in the Department of Commerce lobby, Washington, D. C., will be formally opened at 2:00 p.m., May 10. This exhibit, showing many technical advances made by inventors in the mechanical field under the American Patent System, is made possible through the co-operation of several leading companies. It will be open daily from 8:30 a.m. to 10:00 p.m.

NSPE Annual Meeting

"ENGINEERING's Decade of Decision," will be the theme of the National Society of Professional Engineers' annual meeting in Boston, Mass., June 8–11. Hugh L. Dryden, Fellow ASME, deputy administrator of NASA, and Admiral Arleigh Burke, chief of naval operations, will be among the featured speakers.

British Exhibition

A BRITISH exhibition of industry, technology, science, and culture to be held in the New York Coliseum, June 10–26, will include the most complete display of British industry ever shown in the U. S. Sponsored by the Federation of British Industries with the support of the British Government, the exhibition is designed to give the American public a chance to know Britain and its wide range of industrial goods better.

COMING MEETINGS

Industrial Engineering

CORNELL UNIVERSITY, Ithaca, N. Y., will be the site of the annual Industrial Engineering Seminars, June 14–17. Sponsored by the Department of Industrial and Engineering Administration, Sibley School of Mechanical Engineering, the sessions will include such topics as industrial management, engineering administration, work measurement, and statistical decision making.

Heat Transfer

THE 1960 Heat Transfer and Fluid Mechanics Institute will be held June 15–17, at Stanford University, Stanford, Calif., for the purpose of presenting advances in fluid mechanics, heat transfer, and related fields.

Engineering Education

THAT engineering education is currently in a state of change is reflected in the program which the American Society for Engineering Education has planned for its 68th annual convention at Purdue University, Lafayette, Ind., June 20–24. Engineers and educators will hear a "Report on the Survey of Technical Institute Education" and will attend a session on "Long Range Education and Development of the Engineer," among others.

Creativity Conference

IDEAS, inventions, and new products destined to increase the gross national product of the country go on the auction block at the National Invention's Exhibition and Creativity Conference sponsored by the Cleveland Engineering Society to be held at the Cleveland Engineering and Scientific Center, June 20–24. More than 150 inventors will display models of their inventions. All of them will be patented or patentable; and most will be for sale, lease, or available for development.

International Industrial Conference

THE International Industrial Conference, a world-wide meeting of business and industrial leaders, will convene in San Francisco, Calif., in September, 1961. The meeting is expected to bring together more than 500 executive officers representing more than 50 countries of the free world.

The 1961 conference, organized entirely under private auspices, will be sponsored by Stanford Research Institute and the National Industrial Conference Board. The conference will explore such areas as: (*a*) Trade, investment, and economic co-operation among nations, covering emergence of regional trading blocs, economic implications of intensified competition for markets, and pressures of rising populations for higher living levels; (*b*) management and organizational problems involved in expanding business enterprises, domestic and foreign, (*c*) provision, training, and development of strong and enduring leadership to the successful conduct of business enterprises throughout the world.

Until September, 1961, conference headquarters will be at SRI in Menlo Park, Calif.; eastern headquarters will be at the NICB, 460 Park Avenue, New York, N. Y.

Meetings Abroad

● **Congress of Engineers in Argentina.** Argentine engineers will be host to two meetings in September: The Pan American Congress on Engineering Education, Sept. 12–16, and the Seventh Convention of the Pan American Association of Engineering Societies, Sept. 19–23, both in Buenos Aires.

● **International Heat Transfer Conference.** The second International Heat Transfer Conference, 1961–1962, will take place in Boulder, Colo., Aug. 28–Sept. 1, 1961, and will be repeated in London, Jan. 8–12, 1962. Arrangements for the ASME and The Institution of Mechanical Engineers joint conference are being made by organizing committees under the chairmanship of A. C. Mueller, Mem. ASME, in the U. S., and Prof. O. A. Saunders in Britain. The basis of the conference will be papers dealing with fundamental aspects of heat transfer.

● **Cataloging Principles.** A conference designed to promote international uniformity in cataloging will be held at UNESCO House, Paris, in 1961. It will be organized by the International Federation of Library Associations with A. H. Chaplin, British Museum, London, as Executive Secretary, to whom one should write for further information.

International Congress on Combustion Engines (CIMAC) in Denmark, June, 1962

THE U. S. National Committee of the International Congress on Combustion Engines (CIMAC) recently announced that the next congress will be held at Copenhagen, Denmark, in June of 1962.

The theme of the congress will be: Recent developments with diesel engines and gas turbines above 3000 hp and with gas engines above 1500 hp.

The U. S. National Committee is sponsored by the Oil and Gas Power Division and the Gas Turbine Power Division of The American Society of Mechanical Engineers.

John C. Gibb, Chairman of the OGP Division, is Chairman of the U. S. National Committee. The Vice-Chairman is R. Tom Sawyer, Treasurer of the GTP Division.

Anyone interested in presenting a paper at this meeting is urged to send a résumé to the U. S. National Committee before Dec. 15, 1960. The résumé, not to exceed two typed pages, must include a list of probable figures, graphs, and tables. The official languages for the congress are English and French.

The last CIMAC meeting was held in Wiesbaden, Germany, in June, 1959, and was attended by 1000 men and women from 27 countries including 42 from the United States.

For information on the preparation of papers for the meeting, or for future announcements, write to: Robert L. Stanley, Secretary of the U. S. National Committee, 2000 K Street, NW, Washington 6, D. C.

U. S. Forest Products Lab to Celebrate Golden Anniversary, June 2–4, Madison, Wis.

THE Golden Anniversary of the U. S. Forest Products Laboratory, oldest research organization of its kind in the world, will be observed June 2–4 at Madison Wis., where the trail-blazing institution was founded 50 years ago.

Plans for the celebration are rapidly taking final form. The three-day affair will be touched off with a banquet Thursday evening, June 2. At a general meeting of Laboratory staff and guests Friday morning, key leaders in industry, government, and education will speak on various facets of research, past and future. And on Friday afternoon guests will tour the Laboratory to view special exhibits and witness dedicatory ceremonies. The Laboratory staff will hold open house for the public all day Saturday.

The pioneer Laboratory was dedicated June 4, 1910, to a career of public service which has yielded rich returns to both producers and consumers of a multitude of wood products. High among its achievements are such industrial advances as:

1 New pulping processes for species once thought to be useless forest "weed."

2 Basic production and engineering discoveries that helped launch the nation's house-prefabrication and timber-laminating industries.

3 Kiln drying and other wood-seasoning processes that swiftly and safely remove excess sap from many millions of board feet of lumber annually.

4 Preservatives and processes used by industry to immunize huge quantities of wood against decay and fire.

5 Packaging research that has greatly reduced shipping costs and losses during peace and war.

Co-operative efforts of the University of Wisconsin and the Forest Service, U. S. Department of agriculture, brought the Laboratory into existence.

Throughout its half-century history, the Laboratory has co-operated closely with industry groups. Staff members take numerous committee assignments in such organizations as the American Society for Testing Materials, the Forest Products Research Society, the Technical Association of the Pulp and Paper Association, the American Chemical Society, and the American Wood-Preservers' Association. These organizations help disseminate results of the Laboratory research in the form of quality standards voluntarily adopted by industry, industry-devised grading rules for various wood products, and design and production requirements. Industrial concerns and associations also support special research projects at the Laboratory. Such work is accepted if generally useful results are likely to be obtained.

The Laboratory is the designated authority for wood identification among federal agencies and furnishes this service free to the public. It works closely with the Army, Navy, and Air Force in drawing up specifications, handbooks, manuals, and the like, as well as conducting research on Department of Defense problems through co-operative arrangements.

Special exhibits at the Golden Anniversary celebration are planned to demonstrate the progress of Laboratory research from its beginnings to the present—from "the horse-and buggy age into the age of rockets."

Dr. Edward G. Locke is the Laboratory's sixth director, having taken office last year.

INDUSTRIAL FILMS

Conveyers

"CONVEYORS for Parts, Assemblies, and Packages" is a new 16-mm sound film produced by the College-Industry Committee on Material Handling Education. The black and white film, produced with the co-operation of The Material Handling Institute, Inc., portrays and de-

scribes all types of industrial conveyer systems, showing how they have progressed from the antiquated 1912-vintage systems to those that play a vital part in today's highly automated industries.

It covers how and why conveyers are used in the manufacture and production of such diverse products as automobiles, household appliances, and marine equipment. Cost of the film is $90 to industrial organizations, and $65 to educational institutions. Rental cost is $4 per showing. Available from: Herbert E. Farmer, Director of Services, Cinema Department, University of Southern California, Los Angeles 7, Calif.

Fuel Cells

A NEW 16-mm, seven-min, sound-color film "The Fuel Cell Tractor" describing work involved in obtaining electrical energy from fuel cells has been produced by Allis-Chalmers Manufacturing Company audio-visual section. It shows researchers as they tested and hand-built the fuel cell equipment first applied in a tractor for demonstration purposes. Although the basic theory of fuel cells has been known for 120 years, refinements of the original concept by Allis-Chalmers research laboratories has made this method of producing electricity from a chemical reaction practical. Available from: Allis-Chalmers sales offices.

Control Manufacturing

"NUMERICAL Control Manufacturing," a 16-mm color motion picture, shows the advantages and cost savings resulting from use of numerically controlled machine tools and how they are used in typical applications. The 22-min film gives a complete description of the Bendix Aviation Corporation's numerical control system. Available from: Industrial Controls Section, Bendix Aviation Corporation, 21820 Wyoming Ave., Detroit 31, Mich.

Film Libraries

MORE than 80 16-mm films describing American work simplification and industrial engineering techniques are included in the 1960 edition of the Industrial Management Society free film rental catalog. The films are 10–15 min long; many are in sound and color. Brochure available from: Industrial Management Society, 330 South Wells Street, Chicago 6, Ill.

RESEARCH

Powder Metallurgy

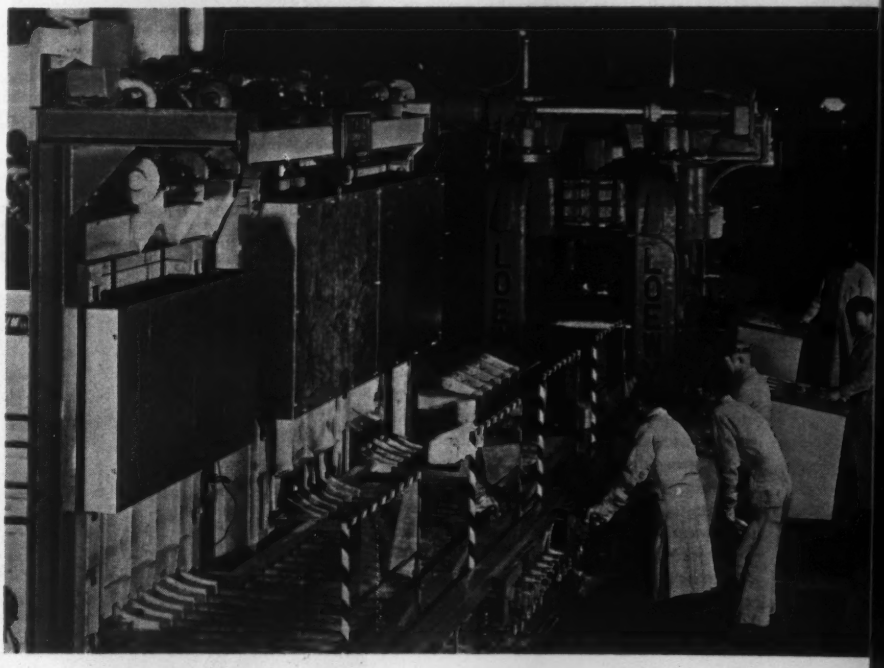
A TOTAL of $400,000 in government and industrial contracts has been awarded to Stevens Institute of Technology to develop new methods of producing metal parts such as components for use in missiles by the casting at room temperatures of liquid suspensions of fine metal powders. The research is being carried out at the Stevens Powder Metallurgy Laboratory under the direction of Gregory J. Comstock.

The new contracts include work on fuel elements for use in nuclear power reactors; developing new techniques for economically producing components of metals and alloys with excessively high melting points; and producing from steel alloys ordnance parts which will be subjected to high stresses. The cold casting process to be used in this research is a new and major break-through in powder metallurgy.

Pumping Liquid Metals

How are pumps affected by molten metals? The answer to this is important to the design of nuclear power plants which use "liquid metals" such as mercury, sodium, sodium-potassium, and lead-bismuth as heat removal media or as power-plant working fluids. Frederick G. Hammitt, Mem. ASME, of the mechanical and nuclear engineering departments at the University of Michigan is searching for part of the answer. He is investigating erosion and cavitation in the pumping of liquid metals. To carry out this study, administered by the University of Michigan Research Institute, he was given $93,710 under a two-year grant from the National Aeronautics and Space Administration.

For United States Steel, research holds a key to the future. Here scientists and technicians at the Corporation's Applied Research Laboratory, Monroeville, Pa., operate what is perhaps one of the newest and most versatile rolling mills of its size in the world. The miniature mill is almost completely automated and is shown about to roll an experimental steel ingot which has just come from one of the new atmosphere-controlled heating furnaces.



The Petroleum Activities Committee of the ASME Mid-Continent Section has been doing a land-office business at their luncheon-forum meetings (see MECHANICAL ENGINEERING, March, 1960, p. 130, and April, 1960, pp. 140–141). The men who organized this popular luncheon series are shown with their last speaker of the season. Standing, left to right, are R. P. Lennart, chairman of the pipeline committee; Earl Seaton, news committee chairman; W. W. Weltmer, speaker at the March 15 forum luncheon; Harry Evans, director of the Petroleum Activities Committee of the Mid-Continent Section of ASME; W. R. Clarke, chairman of the drilling and production committee; and the Rev. Fred C. Knight, Jr., who gave the invocation at the luncheon. Seated, left to right, are Robert W. Smith, news committee vice-chairman; Bill Forney, materials committee chairman; Paul Exline, membership committee chairman; and G. O. Bates, chairman of the refining, gas, and gas products committee. Other committee members not present are John W. Towner, secretary-treasurer; and Alva C. Smith, meetings arrangements committee chairman.

ing of ASTM Committee D-13 on Textile Materials, Sheraton Atlantic Hotel, New York, N. Y.

EDWARD T. VINCENT, Fellow ASME, professor-emeritus of mechanical engineering at the University of Michigan, has been awarded a Certificate of Achievement by the U. S. Army for "exceptional contributions to the Army's mission in the field of soil-vehicle mechanics."

JAMES F. FAIRMAN, senior vice-president, Consolidated Edison Company of New York, has been selected to receive the 1960 National Society of Professional Engineers Award for outstanding service to the engineering profession. Presentation will be made at the Society's annual meeting in Boston, Mass., June 11, 1960.

PROF. LEO SZILARD of the University of Chicago has been named recipient of the Albert Einstein Gold Medal and Award for 1960. During World War II, he was chief physicist at the Metallurgical Laboratory of the University of Chicago,

PEOPLE

Honors and Awards. AUGUSTIN L. QUENEAU, metallurgical consultant and retired technical assistant to the president of U. S. Steel Corporation, was awarded the Egleston Medal, Columbia University's highest award for "distinguished engineering achievement." The medal, sponsored by the Columbia Engineering School Alumni Association, was presented April 23, 1960, as part of the annual Engineering Dean's Day program.

The 1959 James Clayton Prize given annually by The Institution of Mechanical Engineers (London) was presented to CEDRIC BERNARD DICKSEE for his pioneering and subsequent development and research work on the high-speed compression-ignition engine, and to GRAHAM FERNIE MUCKLOW for continuous research and experimental work into propagation of pulses in gases and problems connected with the internal-combustion engine, and for his contributions to knowledge in that field of mechanical engineering.

WERNER VON BERGEN, associate director of research with J. P. Stevens & Company, received the Harold DeWitt Smith Award for outstanding service to the textile industry. The honor was given March 3, 1960, at the spring meet-

Aristide Antoine, left, who set up the inspection department for Electricite de France when the Utilities were nationalized in 1946, describes African hydroelectric project to L. N. Rowley, Fellow ASME, and editor of Power; and Dean Freiday, assistant editor, Mechanical Engineering, during a press conference recently held at ASME Headquarters. A member of the Economic and Social Council, Colonel Antoine also is chairman of the Electrical Society of Guinea. He described the 9000-kw Grandes Chutes, Guinea; 20,000-kw Chute d'Edea, Cameroon, and the 15,000 Chutes du Djoue, French Equatorial Africa hydroelectric projects which are being built with French capital as a start on the development of Africa's water power which represents 40 per cent of the world's total resources.

Glenn B. Warren, left, vice-president and consulting engineer, Turbine Division, General Electric Company, receives portfolio of letters written by many friends in ASME Hudson-Mohawk Section for his "inspiring leadership, wise administration, and imaginative planning as President of The American Society of Mechanical Engineers," from Section Chairman Sten-Eric E. Weidler. The presentation was made March 16, 1960, at the fourth Annual Section Student Dinner, which more than 100 members and guests attended. Mr. Warren spoke on "The Role of Professional and Technical Societies in the Engineer's Career." John O. Amstuz, Fellow ASME and First Deputy Commissioner of the New York State Department of Commerce, also addressed the group. His topic was "The World We Live In and the Problems Confronting Us." Productivity has risen little in the United States in the past five years, Amstuz pointed out, in comparison with the big gains made by the rest of the world. He called for more productivity, more imagination, more initiative, and more determination on the part of Americans to meet growing foreign competition.

operated for the Manhattan District which was conducting the atomic weapon project for the War Department.

THE PHILLIPS PETROLEUM COMPANY has been selected to receive the first annual Industrial Professional Development Award of the National Society of Professional Engineers. The award will be presented at the NSPE annual Meeting in Boston, Mass., to be held June 8–11.

New Appointments. ALVIN M. WEINBERG, director of Oak Ridge National Laboratory, and GEORGE BEADLE, California Institute of Technology, have been appointed by President Eisenhower to serve on his Science Advisory Committee.

LIEUT. GEN. JAMES M. GAVIN, retired U. S. Army, has been elected president of Arthur D. Little, Inc., Cambridge, Mass., international industrial research company. He was formerly vice-president.

ROBERT L. DAUGHERTY, Fellow and past Vice-President, ASME, and professor-emeritus, California Institute of Technology, has been reappointed to a third three-year term as member of the Air Pollutions Control Hearing Board by the Los Angeles County Board of Supervisors, Los Angeles, Calif.

GEORGE A. HAWKINS, Fellow ASME, Dean of Engineering, Purdue University, has been appointed to serve on the National Science Foundation's Science Information Council for a four-year term.

New Officers. GEORGE E. HOLBROOK, vice-president, director, and executive committee member of E. I. du Pont de Nemours & Company, Inc., has been elected vice-president of Engineers Joint Council.

JOSEPH MODREY, Assoc. Mem. ASME, Chairman of the Department of Mechanical Engineering, Union College, has been elected National Vice-Chairman of the Mechanical Engineering Division of the American Society for Engineering Education.

Campus Data. HSUAN YEH, Mem. ASME, professor of mechanical engineering at the University of Pennsylvania, has been appointed director of the new Towne School of Civil and Mechanical Engineering. The appointment will become effective July 1, 1960, when the Towne School will be established by combining the University's Schools of Civil and Mechanical Engineering.

MARIO J. GOGLIA, Mem. ASME, Dean of the College of Engineering at the University of Notre Dame, has been appointed Associate Dean of Faculties at the Georgia Institute of Technology, effective July 1, 1960.

C. QUENTIN FORD of New Mexico State University's mechanical engineering faculty has been appointed head of the Department of Mechanical Engineering, effective fall, 1960. A. M. LUKENS, Mem. ASME, head of the department for the past 19 years, will continue on the faculty as professor of mechanical engineering.

Among eight outstanding engineering students awarded three-year National Defense Graduate Fellowships for advanced study in Systems Engineering at Case Institute of Technology, Cleveland, Ohio, are: JULIUS L. MARCUS, Student Member, ASME, Case Institute of Technology; and NEIL F. SHEPARD, Student Member, ASME, Rutgers University. The fellowships, presented by the U. S. Department of Health, Education, and Welfare solely on the basis of scholarship and ability in science and engineering, are the only ones awarded in Systems Engineering in the United States.

JAMES E. NEWSOME was elected national president of the Society for Advancement of Management at the 15th annual Management Engineering Conference, an event jointly sponsored by SMA and the Management Division of The American Society of Mechanical Engineers, held at the Statler Hilton Hotel, New York City. Mr. Newsome is production manager for the Chicago, Ill., plant of Johnson & Johnson.

Tyro Tycoon—That's a Young Engineer

THE average starting salary offered 1960 engineering graduates at Stevens Institute of Technology will probably reach $525 per month, an all-time high, according to Harold R. Fee, Director of Placement at the college.

Mr. Fee based his prediction on meetings with industrial representatives who arrived on campus February 15, to interview 216 seniors as prospective employees. The six-week interviewing period will bring to Stevens a total of 230 companies from New Hampshire to California. This is the largest number ever to visit the college.

Engineer's Market. "It's an engineer's market again this year," Fee said. "And nowadays industry seems determined to keep its new engineers. Beginners receive yearly raises in line with their higher starting salaries. In 20 years our present crop of seniors will be making far more than 1940 graduates do now."

Salaries Rising. He pointed out starting salaries for engineers have been steadily rising since 1955 when $378 per month was average. The number of companies sending recruiters to Stevens has also jumped from the 1955 figure of 167, Fee added.

He said there would be more job offers and more interviews per Stevens senior this year than last year. In 1959, 189 Stevens men met with representatives of 209 companies; received three job offers each; took 16 interviews per man; started at an average salary of $502 per month.

"Each student takes an unusually large number of interviews because he is not tagged by the companies as a specialist. Thus he is qualified in a wide range of science and engineering fields," Fee explained. "The Stevens nonspecialized program gives him a solid foundation in the major engineering areas."

Good Grades. Mr. Fee said that companies continue to emphasize good grades and extracurricular activities in hiring seniors. "They are also looking for people who work well with others since so much engineering development these days is done by research teams.

"Greatest demand for engineers will be in manufacturing, electronics, aircraft, and petroleum industries," Fee said. "A number of seniors will obtain scientific positions; others will continue their studies in graduate school."

Interviews end just before the Easter recess so that seniors can follow up with plant visits during their vacation.

New York City Scientific Literature Resources to Be Studied

THE New York Chapter of the Special Libraries Association has inaugurated a co-operative community program to strengthen that city's science and technology literature resources to meet current and future needs. To conduct this program a special Committee on Science-Technology Resources has been established to study possible methods of cooperation and to recommend appropriate action.

The Committee's first objective will be to study existing information sources in the New York City area and consider the need for additional published guides to facilitate their use. It is expected that valuable unique collections and special sources of information not normally recognized would be made known and more accessible by the provision of appropriate indexes, directories, and guides.

The current heightening of interest in

Soviet science, for instance, makes it most important that information be available on sources of Russian journals, abstracts, indexes, and individual papers, both original and English-language editions.

The charter membership of the Resources Committee consists of the representatives of American Iron and Steel Institute Library, American Petroleum Institute Library, Chemists' Club Library, Columbia University Libraries, Engineering Societies Library, Institute of Aeronautical Sciences Library, and the Science-Technology Division of New York Public Library. The Committee expects to expand its membership to include representatives of all subject fields of science and technology. It also plans to co-operate with other groups working on local, regional, or national levels when their programs coincide with or supplement the New York effort.

The Committee on Science-Technology Resources is particularly interested in receiving news of other groups working on similar programs. Communications should be addressed to the Chairman of the Committee, Miss Anne McCann, Library, Squibb Institute for Medical Research, New Brunswick, N. J.

EDUCATION

Engineering Students

DEMANDS for college-trained engineers is rising and the number of students enrolling for engineering courses is dropping, according to a report by the Engineering Manpower Commission of Engineers Joint Council. The commission urged educators, guidance counselors, and parents as well as industry and government to take steps to insure availability of enough engineers and the right kind to meet the nation's demand for technical services.

Faced with this "turbulent technological scene," according to Gordon S. Brown, dean of engineering, M.I.T., "engineering colleges are adjusting to the challenge by presenting students a more integrated body of fundamental knowledge, at the sacrifice of the specialized knowledge characteristic of the past." As a result, many graduates of a modern four-year curriculum are capable of a career in any one of several industries.

The answer to the needs of specialization lies in more postgraduate work at universities, the offering of training courses by industry, and the affording of opportunities for engineers to obtain refresher instruction.

Industry. According to a report in *Overview*, a new magazine for educational executives, industry is today the fastest growing segment of the entire educational enterprise. The General Electric Company alone last year spent an estimated $40 million educating its employees—and GE is by no means the largest industrial spender.

Some of this industry education is in the form of on-the-job training, but most of it is actual classroom work, either at the plant or at a nearby college. At IBM's Kingston, N. Y., facility, 1300 employees enrolled for company-sponsored study last year out of a total work force of 5500.

Since change is inevitable, industry considers it necessary not only to keep pace with these changes, but to influence them. Hence private firms are vigorously expanding their education programs. Further, companies are appropriating funds and granting universities land for development of educational facilities.

● Republic Aviation Corporation has donated 25 acres of land to Polytechnic Institute of Brooklyn where a graduate engineering school will be established. With its attendant research laboratories, this Polytechnic Center for Graduate Study and Research will cost $1,200,000.

● The Texas Atomic Research Foundation and General Dynamics Corporation announced that they will award six research fellowships this summer to Texas graduate students for work at General Dynamics' General Atomic Division in San Diego.

● The University of Pennsylvania has shared notably in the growing corporate support of colleges and universities. During the fiscal year 1958–1959, 538 corporations and companies aided Pennsylvania. Exclusive of grants for contract research, corporate giving amounted to $1,507,000, roughly 14 per cent of the total amount of money contributed by all sources to the university during the past year. Gifts for new construction accounted for 59 per cent of the total $15 million in building projects currently under way.

According to a release by the Council for Financial Aid to Education there was a 23.5 per cent increase in corporate aid to education over the two years from 1956 to 1958, revealed by a survey of the country's 1500 largest corporations. Most of these gifts were unrestricted as to their usage.

Co-operative Education

GENERAL MOTORS INSTITUTE, an engineering college, offers programs in mechanical, industrial, and electrical engineering on the co-operative plan. The Institute is evidence of recognition by General Motors Corporation of the need for young men to have a good education to be able to qualify for engineering, technical, and managerial positions, and of the necessity for industry to assist in the development of young men to qualify for future industrial leadership.

The Institute was started in 1919 and has developed into one of the world's largest industrial educational institutions. As the central training agency for General Motors, it assists the managements of the various divisions in the development of personnel for their organizations.

Under the co-operative plan, the student spends alternate periods in class and laboratory study at the Institute, and in carefully planned work assignments at his sponsoring General Motors plant.

High-school seniors who are interested in appointment to the program can secure an application blank from either the Registar, General Motors Institute, Flint, Mich., or the personnel department of any General Motors plant.

A bulletin, "Engineering Education on the Co-operative Plan," may be obtained as an aid to prospective students of General Motors Institute.

Creative Problem-Solving Institute

THE sixth annual Creative Problem-Solving Institute, cosponsored by the University of Buffalo and the Creative Education Foundation, will be held June 27–29 on the UB campus.

Objectives of the Institute are as follows: Self-improvement—to enable members to enhance their own creative ability; Education—to teach members how to teach others to be more creative; Operational use—to train members in the use of proved techniques for maximum production of ideas; Leadership—to prepare members for leadership in organizing and conducting creative problem-solving activities; Knowledge—to enlighten members on the latest developments and research in the creative thinking field; Interchange—to provide opportunity for members to confer personally with each other and with experienced leaders.

Teacher-Training Program

●**ASEE-AEC.** SPECIAL training in nuclear energy has been given to 433 engineering and science teachers and 50 instructors from technical institutes in the jointly sponsored summer programs of the Ameri-

can Society for Engineering Education and the U. S. Atomic Energy Commission.

The six eight-week programs for 1959 were offered at Cornell University and Brookhaven National Laboratory, North Carolina State University and Oak Ridge National Laboratory, Argonne National Laboratory, University of Michigan, Hanford Atomic Products Operation of the General Electric Company, and Pennsylvania State University and Argonne National Laboratory. Similar programs have been offered for the past four summers and will be offered again in 1960.

● **NSF.** Financial aid will be available in 1960 for about 18,000 high school and college teachers of science, mathematics, and engineering to participate in Summer Institutes sponsored by the National Science Foundation. Three hundred and seventy-nine Institutes will be supported by the Foundation next summer, in 265 educational institutions.

Educational Reactors

● Iowa State University, Ames, Iowa, and the University of Missouri, Columbia, Mo., have joined the growing ranks of educational institutions which are adding nuclear facilities.

The Iowa reactor, UTR-10, is designed specifically for engineering school use. It embodies all essential elements of nuclear-power producing systems. A model of an actual operating water reactor, UTR-10 was designed and built by Advanced Technology Laboratories, American-Standard, Mountain View, Calif.

● The University of Missouri's new reactor will be made possible by a $1\frac{1}{4}$ million state appropriation and will be directed by Ardath H. Emmons, formerly on the faculty of the University of Michigan.

Endowments

Rensselaer Polytechnic Institute, Troy, N. Y., has received a gift of $1 million from Mr. and Mrs. Erik Jonsson, Dallas, Texas, through the Jonsson Foundation to help finance a new Science Center.

Clarkson College of Technology, Potsdam, N. Y., has received a pledge of $20,270 for a construction equipment distribution scholarship fund.

Polytechnic Institute of Brooklyn has been awarded a grant of $60,000 by the National Science Foundation to establish a modern, high-speed electronic computer facility.

Fellowships and Scholarships

A number of visiting faculty opportunities in engineering education have been made available at twelve universities as part of the new Ford Foundation program in Science and Engineering. The purpose of the $2 million, 5-year program is to strengthen the ranks of engineering teachers and to enhance the quality of experimental curriculum approaches.

Grants were made to nine institutions to enable faculty members at other schools to better themselves professionally by participating in activities at one of the institutions. These institutions are California Institute of Technology, University of California (Berkeley), Carnegie Institute of Technology, University of Michigan, Purdue University, Stanford University, University of Wisconsin, University of Illinois, and Massachusetts Institute of Technology.

Grants were made to six institutions for projects for educational experimentation pointed toward curriculum development.

A $1.1 million engineering Fellowship-Loan program has been established at ten universities to increase the number of qualified engineering teachers by encouraging and accelerating education through the doctoral degree.

● **American Die Casting Institute.** The annual Doehler Award of the American Die Casting Institute will consist of a plaque and a cash honorarium of at least $500.

The Award is to be made for outstanding contributions to the advancement of the die casting industry or to the art of die casting. Nominations will be received from January 15 to April 15 of each year. Address entries to: Award Committee, American Die Casting Institute, 366 Madison Avenue, New York, N. Y.

● **Atomic Energy Commission.** Announcement has been made of the establishment of an Ernest Orlando Lawrence Memorial Award for recent, especially meritorious contributions to the development, use, or control of atomic energy. The award which will be made by the Commission upon recommendation of its General Advisory Committee and with the approval of the President, will consist of a medal, a citation, and an honorarium amounting up to $25,000.

● **National Lime Association,** Washington, D. C., has announced the Victor J. Azbe Lime Award Contest. An award of $1000 will be given for the best technical paper on lime—its manufacture including plant or equipment design, research on its chemical and physical properties, and methods of tests for evaluating its properties and quality. Further details of the contest may be obtained from the National Lime Association, 925 15th Street, N. W., Washington 5, D. C.

Campus Improvements

● Northeastern University is replacing and adding to its Mechanical Engineering Laboratory $45,000 worth of new instructional equipment. The vast changeover is planned to result in general upgrading of the quality of instruction in the department of mechanical engineering.

● Stevens Institute of Technology has announced plans for the "Stevens Center," a 13-story building to be constructed on top of Castle Point, overlooking the Hudson River. The new building will become the hub of nonacademic activity and will house student and faculty dining areas and kitchens as well as the college book store, post office, lounges, and so on.

● The Atomic Energy Commission has granted Stevens Institute of Technology an additional $44,000 to equip a laboratory for an undergraduate course in nuclear engineering. This brings AEC total grants to $156,000.

● Columbia University has received $44,200 from the Atomic Energy Commission to expand its nuclear science and engineering program. The funds will be used to purchase an ion accelerator and a multichannel analyzer for experiments water-moderated and graphite-moderated "subcritical" atomic reactors.

Medical Engineering

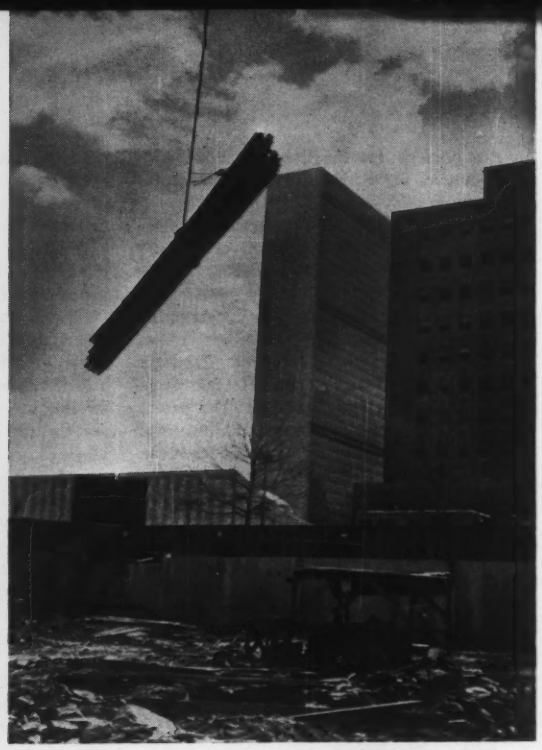
College students may soon be studying for a new kind of academic degree in a new profession—medical engineering, according to Hans H. Zinsser, MD, of the Columbia University College of Physicians and Surgeons.

In a paper delivered recently at the international convention of the Institute of Radio Engineers, Dr. Zinsser stated that if real progress is to be made in bridging the gap between medicine and biology on the one hand and the physical sciences on the other, a new breed of professional worker will have to be trained who is competent in both fields.

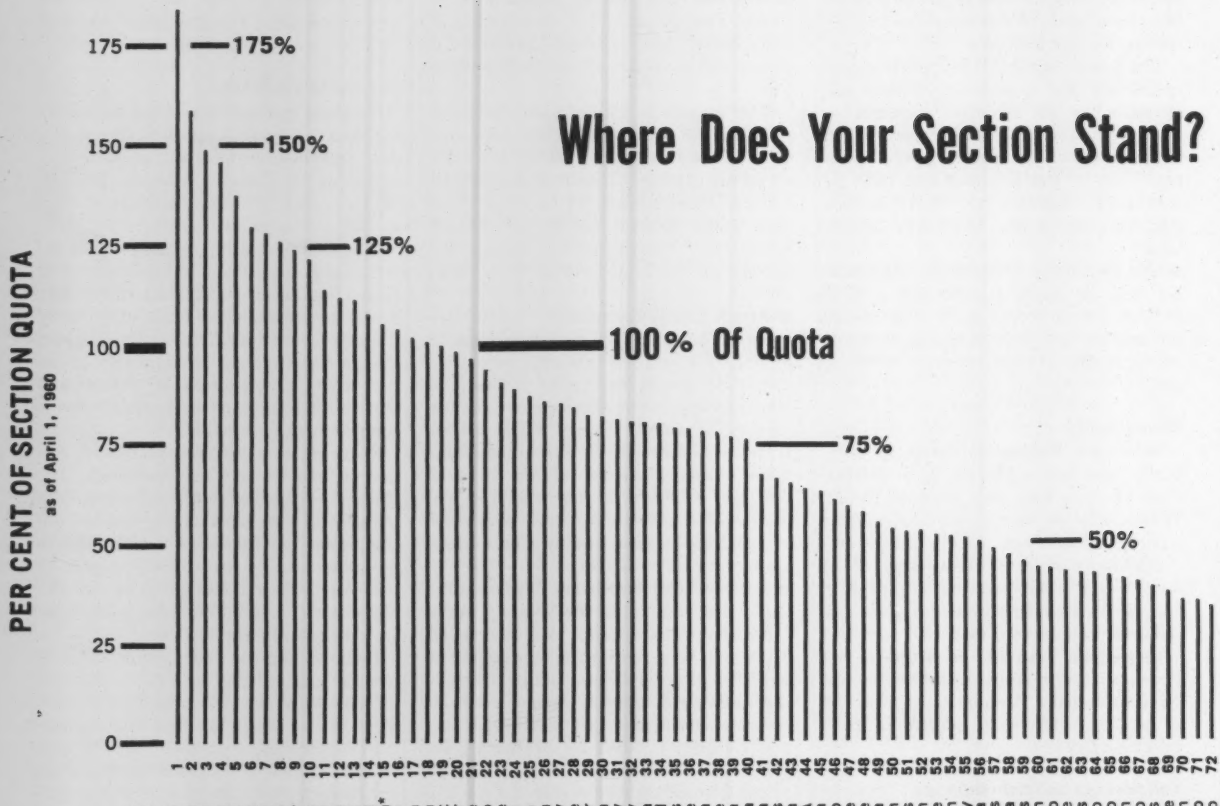
Speaking at a medical electronics session at the New York Coliseum, Dr. Zinsser outlined a suggested curriculum in medical, or biomedical, engineering comprising a four-year undergraduate program leading to the BS degree, a two-year postgraduate program for the MS degree, and a four-year postgraduate schedule for the PhD degree.

Commenting on the importance of medical engineering, Dr. Zinsser stated, "Technology can derive very real gains from the intimate analysis and replication of biological devices. In the field of transducers, orientation mechanisms, and information integration, many biological systems transcend any mechanical systems thus far devised."

United Engineering Center



Where Does Your Section Stand?



▲ Steel reinforcing rods hover over United Engineering Center site just before being dropped to excavation. View is southeast, toward corner of United Nations Plaza and 47th Street, in New York City. UN and Carnegie buildings are in background.

UEC Construction on Schedule; Design Calls for Stainless-Steel and Glass Sheathing

"Construction of the United Engineering Center is on schedule or a little bit ahead." That's the report from the construction site at 47th Street and United Nations Plaza in New York City. Excavation for footings is virtually complete, about half of the basement walls already have been poured, plumbing work has begun, floor slabs were poured late in April. And this month steel erection is scheduled to begin.

Meanwhile, in the fund-raising campaign for the Center, end-of-month returns show that the American Institute of Consulting Engineers has joined the American Institute of Chemical Engineers in having achieved 100 per cent of its quota, and the American Institute of Industrial Engineers has passed the 85 per cent mark.

The four societies with highest quotas remaining to be achieved had reached, as of April 1, the following percentages of their quotas:

ASCE 91.6 per cent achieved
AIEE 92.0 per cent achieved
ASME 83.5 per cent achieved
AIME 74.6 per cent achieved

The industrial campaign has achieved approximately $4,900,000 in gifts and pledges.

Details of construction specifications recently were made public by United Engineering Trustees. Designed as a basic glass and stainless-steel grid system with fixed windows, glass spandrels, and a masonry service core, the new $12,000,000, 20-story Center will use 20 to 14-gage stainless steel, Type 302 for the window frames, mullions, and column covers.

The lobby, with the main entrance on 47th Street, will be walled in marble with floors of terrazzo. Two corridors lead from the lobby to meeting rooms and dining rooms on the first floor. On the east side, a display area of 6235 sq ft will feature ceiling height windows. Approximately half the ceiling height will be 15 ft with the other half rising 22 ft 3 in. Movable partitions in this area, as well as in meeting rooms and dining rooms, will permit adaptation of space to special purposes.

Elevators, along the west wall, will be capable of speeds of 700 fpm. Four elevators will be installed to meet present needs, with provision for two more in the future if needed.

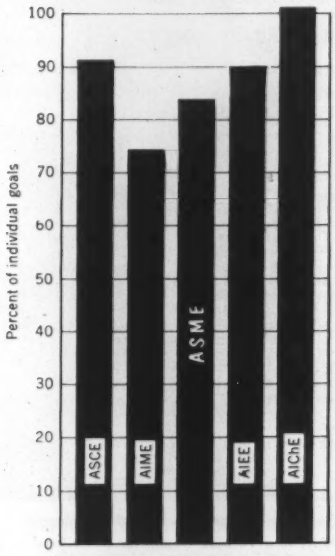
Provisions for future expansion of office space has also been made on the northwest side of the building. The expansion could add as much as 8500 sq ft of floor space from the third to the eighth floors and 6000 sq ft from the ninth to the twelfth.

Altogether, the Center will rise 283 ft above street level, including 18 floors of office space and two of mechanical equipment. A basement provides space for a dining room seating 350, serving counter, and an employees' lounge. Other basement space is devoted to kitchen, mechanical and electrical equipment, and maintenance facilities.

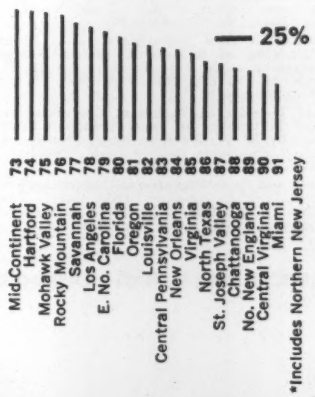
The Engineering Societies Library and Engineering Index will be housed on the second floor, with reading room facilities for 74 persons at a time and stack facilities (including a small elevator) for an ultimate capacity of 225,000 volumes.

Air conditioning, with zoned control, will operate throughout the building. A light level of 75 foot-candles will be maintained in all offices.

How Is ASME Doing?



United Engineering Center Member Gifts Campaign status as of April 1, 1960



Substructures for main lobby and elevator bank are prepared at west side of site. In background, is Carnegie Endowment for International Peace building. Concrete has already been poured in forms at right.

Notes on Society Activities and Events

E. S. NEWMAN
News Editor

THE ASME NEWS

ASME Applied Mechanics Division National Conference, June 20–22, at Penn State

At the twenty-third national conference of The American Society of Mechanical Engineers, Applied Mechanics Division, papers will be presented by authorities including such subjects as thermal stresses in cylinders and beams, buckling loads in conical shells and plates, structures under blast loading, creep in pressure vessels, plastic analysis of shells, vibrations in disks, beams and turbine rotors, bearing stability, and others.

The conference, cosponsored by the Central Pennsylvania Section of the Society, will be held at the Pennsylvania State University at University Park, June 20–22, 1960.

Special features of the meeting include a banquet address on "Exploration of Space," by H. L. Dryden, Fellow ASME, Deputy Administrator of NASA, and a general lecture on "Variational Principles in Elasticity," by Eric Reissner of the Massachusetts Institute of Technology.

▶MONDAY, JUNE 20

Registration 8:00 a.m.

Session 1 10:00 a.m.

Plates and Shells

A Method for Investigating Buckling Loads of Plates and Certain Other Eigenvalue Problems, by *H. D. Conway*, Cornell Univ., Ithaca, N. Y., and *A. W. Leissa*, Ohio State Univ., Columbus, Ohio (Paper No. 60—APM-25)

An Approximate Analysis of the Influence of Aerodynamic Heating and Initial Twist on the Torsional Stiffness of Thin Wings, by *L. S. Han*, Ohio State Univ., Columbus, Ohio (Paper No. 60—APM-13)

The Effect of Pressure on the Bending Characteristics of an Actuator System, by *Paul Seide*, Space Technology Labs, Los Angeles, Calif. (Paper No. 60—APM-16)

Elastic Instability of Rectangular Sandwich Panel of Orthotropic Core With Different Fact Thicknesses and Materials,[1] by *C. C. Chang* and *I.K. Ebcioglu*, Univ. of Minnesota, Minneapolis, Minn. (Paper No. 60—APM-26)

On Saint Venant's Principle: Elastic Shells and Plates,[1] by *P. M. Naghdi*, Univ. of California, Berkeley, Calif. (Paper No. 60—APM-11)

[1] Not presented orally.

Session 2 2:00 p.m.

Shells

Axisymmetrical Buckling of Circular Cones Under Axial Compression, by *L. Lackman*, North American Aviation Co., and *J. Penzien*, Univ. of California, Berkeley, Calif. (Paper No. 60—APM-17)

The Junction Problem of Solid-Slotted Cylindrical Shells, by *D. H. Cheng*, City College of New York, New York, N. Y., and *N. A. Weil*, M. W. Kellogg Co., New York, N. Y. (Paper No. 60—APM-2)

On Strain Hardened Circular Cylindrical Shells, by *Nicholas Perrone*, Pratt Inst., Brooklyn, N. Y., *P. G. Hodge, Jr.*, Illinois Inst. of Tech., Chicago, Ill. (Paper No. 60—APM-20)

Informal Get-Together 8:00 p.m.

▶TUESDAY, JUNE 21

Registration 8:00 a.m.

Session 3 9:00 a.m.

Elasticity—Thermal Stress

General Lecture: **Variational Principles in Elasticity,** by *Eric Reissner*, M.I.T., Cambridge, Mass.

On the Airy Stress Function of Plane Dislocation Problems, by *F. D. Ju*, Univ. of New Mexico, Albuquerque, N. Mex. (Paper No. 60—APM-14)

Thermoelastic Stresses in Beams, by *E. S. Barrekette*, Columbia Univ., New York, N. Y. (Paper No. 60—APM-28)

Transient and Residual Thermal Stress in an Elastic-Plastic Cylinder, by *H. G. Landau*, Columbia Univ., New York, N. Y., and *E. E. Zwicky, Jr.* Gen. Elec. Co., Schenectady, N. Y. (Paper No. 60—APM-14)

Stresses in Curved Beams of Noncircular Centre Line,[1] by *M. M. Abbassi*, Alexandria Univ., Egypt (Paper No. 60—APM-21)

Transient Conduction in Coaxial Cylinders With Relative Motion and Heat Generation,[1] by *V. S. Arpaci*, Istanbul Tech. Univ., Istanbul, Turkey (Paper No. 60—APM-24)

Session 4 2:00 p.m.

Plasticity—Creep

Rupture Instability of Plane Membranes and Solids, by *S. F. Borg*, Stevens Inst. of Tech., Hoboken, N. J. (Paper No. 60—APM-1)

Predication of Creep Failure Time for Pressure Vessels, by *F. Rimrott, E. Mills* and *J. Marin*, Penn State Univ., University Park, Pa. (Paper No. 60—APM-7)

Plastic Analysis of Circular Conical Shells, by *P. G. Hodge, Jr.*, Illinois Inst. of Tech., Chicago, Ill. (Paper No. 60—APM-31)

Modeling of Large Transient Elastic and Plastic Deformations of Structures Subjected to Blast Loading, by *W. E. Baker*, Ballistic Research Labs., Aberdeen, Md. (Paper No. 60—APM-18)

The Elastic-Plastic Thick-Walled Sphere Subjected to Radial Temperature Gradient,[1] by *C. R. Cowper*, Brown Univ., Providence, R. I. (Paper No. 60—APM-22)

Reception 5:30 p.m.

Dinner 6:30 p.m.

Speaker: *H. L. Dryden*, Deputy Administrator NASA

Subject: **Exploration of Space**

▶WEDNESDAY, JUNE 22

Registration 8:00 a.m.

Session 5 9:00 a.m.

Vibration—Dynamics

Dynamic Response of an Elastic Half-Space to Tangential Surface Loadings, by *C. C. Chao*, Stanford Univ., Menlo Park, Calif. (Paper No. 60—APM-29)

Extensional Vibrations and Waves in a Circular Disk and a Semi-Infinite Plate, by *D. C. Gazis*, Gen. Motors Corp., Warren, Mich., and *R. D. Mindlin*, Columbia Univ., N. Y. (Paper No. 60—APM-3)

Vibration Response of a Linear Undamped System Resting on a Nonlinear Spring, by *P. R. Paslay* and *M. E. Gurtin*, Gen. Elec. Co., Schenectady, N. Y. (Paper No. 60—APM-6)

Forced Lateral Vibration of a Uniform Cantilever Beam With Internal and External Damping, by *H. C. Lee*, Rensselaer Polytechnic Inst., Troy, N. Y. (Paper No. 60—APM-15)

Sinusoidal Excitation of a System With Bi-Linear Hysteresis,[1] by *T. K. Caughey*, California Inst. of Tech., Pasadena, Calif. (Paper No. 60—APM-8)

Shock Spectra of a Nonlinear System,[1] by *W. T. Thomson*, Univ. of California, Los Angeles, Calif. (Paper No. 60—APM-23)

Session 6 2:00 p.m.

Bearings—Stability—Fluid Mechanics

Stability of a Turbine Generator Rotor Including the Effects of Certain Types of Steam and Bearing Excitations, by *A. H. Landsberg*, IBM Corp., Yorktown Heights, N. Y. (Paper No. 60—APM-9)

A Study of the Stability of Externally Pressurized Gas Bearings, by *Lasar Licht*, The Franklin Inst., Philadelphia, Pa., and *Harold Elrod*, Columbia Univ., N. Y. (Paper No. 60—APM-5)

On the Theoretical Analysis of a Dynamic Thermocouple, by *W. F. Hughes* and *E. W. Gaylord*, Carnegie Inst. of Tech., Pittsburgh, Pa. (Paper No. 60—APM-19)

Two-Dimensional Gas Jets,[1] by *M. J. Cohen*, Northampton College of Adv. Tech., London, England (Paper No. 60—APM-27)

Assessment of Flow Disturbances at a Blunt Body Traveling at Supersonic Speeds Due to Flow Disturbance in Free Stream,[1] by *M. V. Morkovin*, Martin Co., Baltimore, Md. (Paper No. 60—APM-10)

Thermal Transfer in Turbulent Gas Streams, Effect of Turbulence on Local Transport From Spheres,[1] by *W. W. Short, R. A. S. Brown*, and *B. H. Sage*, California Inst. of Tech., Pasadena, Calif. (Paper No. 60—APM-30)

On Three and Two-Dimensional Disturbances of Pipe Flow,[1] by *K. Spielberg*, IBM Corp., New York, N. Y., and *Hans Timan*, A. B. Dumont Laboratories, Clifton, N. J. (Paper No. 60—APM-12)

Large crowd at SAM-ASME Luncheon Meeting on Thursday, April 7, heard ASME President W. L. Cisler speak on economics of nuclear power

Management Leaders Discuss the Challenges of the Sixties at 15th Annual SAM-ASME Management Engineering Conference

Eight technical sessions and two workshops on management advances and techniques drew more than 1000 engineers

"MEETING the Challenge of the 60's" was the theme at the Society for the Advancement of Management and The American Society of Mechanical Engineers' Management Engineering Conference held at the Hotel Statler, New York, N. Y., April 7–8, 1960.

The more than 1000 engineers in attendance at this 15th Annual Conference heard discussions on advances and techniques in such fields as: Cost reduction, work sampling, new equipment applications, selling industrial engineering ideas, inventory control, clerical cost reduction, indirect labor, and time study and predetermined standards.

In addition, there were two luncheons and two workshop sessions. ASME President Walker L. Cisler, and president of the Detroit Edison Company, talked on "Development of Nuclear Power in the 1960's" at the Thursday Luncheon. At Friday's Luncheon, John L. Young, vice-president of engineering, United States Steel Corporation, Pittsburgh, Pa., outlined, "Labor Implications in the Face of Advancing Technology."

Saul Gass, consultant, Corporation for

(*Continued on page 128*)

"Texas"-Sized Audience Launches First Combined ASME Gas

850 engineers meet in Houston to attend

HOUSTON, whether you refer to the Gas Turbine Power and Hydraulic Divisions Conference or to the city, stays with you. The city has one millionaire out of every eight in the country. There are 27 miles of homes in a single development whose minimum value exceeds $60,000. Most of the downtown business district has been rebuilt within the past 20 years. Its freeways, its medical center consisting of 12 huge hospitals in one district, and its other engineering and civic achievements "out-Texas" Texas.

In the three days, March 6–9, of the conference 59 papers were presented in 20 excellent technical sessions. The conference drew nearly 850 attendees.

Technical Sessions

The Houston conference was not only a joint meeting of two Professional Divisions whose interests overlap in certain areas but it had both practical and theoretical papers. Hydraulic Oldtimers and Fluid Mechanics engineers both found satisfying fare, met on common ground on the topic of cavitation, and may have spawned a new ASME research project.

The Gas Turbine Division drew capacity attendance for a marine-application session in spite of what a gentleman from Washington, D. C., described as "the great distance from the ocean"—actually, Houston ranks second only to New York in port tonnage. It took a good look at the two-shaft versus one-shaft question, peered ten to 20 years ahead at a combined-cycle gas-steam power-generation outfit designed as a single unit, "visited" Europe and Venezuela to see how they were making out with gas-turbine peaking and remote-controlled as well as blast-furnace-fired units, and still had time for consideration of combustion problems and stole into the neighboring camp for a Fluid Mechanics approach to the labyrinth-seal leakage problem.

Symposium on Stall. A three-session joint symposium on compressor stall, surge, and system response drew about 200 attendees and outlined the known facts in this area where instrumentation for research poses such difficult problems. The term stall was limited to the phenomenon in which a "lump" of fluid accumulates in a compressor passage, blocking flow and diverting a portion of it to neighboring passages. In so doing, the angle of attack is changed and stall is soon initiated and advances along the blade row while simultaneously clearing the passages which follow. The progression is unequal and unpredictable, however, so that attempts at control have been "practical" rather than based on an understanding of the phenomenon. In the days of simpler machines, it was sufficient to advance the throttle slowly and thus avoid stall. British practice adapts this approach to more complicated conditions by the use of controlled throttle advance. Demands for more rapid acceleration make it desirable to anticipate the onset of stall so that acceleration can approach the maximum. More research is needed if this is to be achieved. Acoustic impedance and sonic control have been applied with some success.

Papers in the symposium also dealt with analytical approaches, the relation to the ASME Compressor Test Code, and a theoretical generalized analysis of multistage compressor characteristics that will be of value to designers when combined and perfected.

The exhibits arranged by Joseph M. Clark, retired ASME staff member and exhibit manager for the Gas Turbine Power Division, included gas turbines, their components, accessories, and materials used in their construction. Actual gas turbines or full-sized models displayed were: J-44—Aerotest Laboratories, Inc.; GMT-305 Whirlfire automotive-type gas turbine—Allison Division, General Motors; 502 and 520 series—Boeing Airplane Company; 9000-bhp single-shaft gas turbine—Clark Bros. Company; portable 30-hp gas-turbine generator—The Garrett Corporation; 1000 to 2000-hp T53 and T55—Lycoming Division, Avco Corporation; T-1000—Solar Aircraft Company; 430-hp Mark TE—Thompson Ramo Wooldrige; and a small turbojet engine for wing mounting—Williams Research Corporation. Other exhibitors were: AC Spark Plug Division, GMC; the Air Preheater Corporation; Bendix Products Division; Bristol Siddeley Engines, Ltd.; Brown Boveri Corporation; Cameron Iron Works; the Cooper-Bessemer Corporation; English Electric Export & Trading Company, Ltd.; Formsprag Company; Gas Turbine Magazine; General Electric Company; the International Nickel Company, Inc.; the Marquardt Corporation; Wm. W. Nugent & Co., Inc.; Orenda Engines Ltd.; Temple Press Ltd; Westinghouse Electric Corporation; and Woodward Governor Company.

Turbine Power and Hydraulic Conference

20 technical sessions and discuss 59 papers

"Power for an Expanding Economy" was the topic of ASME President Walker L. Cisler's address at the Gas Turbine Power Luncheon. He spoke of the great future need for power both in the United States and in other countries.

A joint session on compressor performance dealt with practical stage-performance correlation for centrifugal compressors as an aid to design. The prediction of approximate performance of turbocompressors with other gases based on data for one gas, and performance evaluation with a multigas mixture were other topics.

Cavitation Symposium. A second three-session symposium was devoted to cavitation. The first session dealt at length with NPSH—its relation to flow abnormalities, speed, and laboratory tests. It was clearly evident that there was little previous correlation of effort in this field, and little standardization of procedures or terminology, although, as W. C. Osborne pointed out, there was general agreement on its importance and the panel members understood each other's work in spite of these lacks.

The second cavitation session was concerned with the effect of air content on the occurrence of cavitation and the influence of entering vorticity field. An experimental study in a mixed-flow pump impeller, and observation of cavitation in a low hub-tip-ratio axial-flow pump

The engineer's mind turned toward an understanding of the laws which govern human behavior may help us advance in our psychological state, according to Harold Grasse, Vice-President of ASME Region VIII

W. V. Houston, president of Houston's Rice Institute, was speaker at the Hydraulic Division Banquet

Hydraulic Division Banquet. Seated at the head table, **left to right,** R. A. Harman, J. L. Schweppe, Mem. ASME, University of Houston, chairman of the arrangement committee; R. C. Dean, Assoc. Mem. ASME, Ingersoll-Rand Company; J. Parmakian, Mem. ASME, Bureau of Reclamation; and Howard W. Emmons, Mem. ASME, Harvard University, Speaker W. V. Houston, president, Rice Institute; W. C. Osborne, Mem. ASME, Hydraulic Division program chairman; Harold Grasse, Mem. ASME, Vice-President of ASME Region VIII; George F. Wislicenus, Mem. ASME, Pennsylvania State University; James H. Anderson, Mem. ASME, chairman of the Gas Turbine Power Division.

impeller were also reported at this time.

The third session was concerned with the special problems of cavitation in the cryogenics region, those of liquid metals, and of pumps where rocket propellants are used. Liquid-metal problems have risen largely from such nuclear applications as sodium cooling.

Nuclear Problems. Nuclear problems have entered another area of hydraulics where water-hammer waves induce pressure oscillations in water-cooled nuclear reactors. The problem, which was theoretically analyzed in the paper, arises when a sudden closure of a check valve interrupts the steady flow of the water column in a pipe, causing the kinetic energy of the flowing water to be converted into the elastic energy of the stretched pipe and compressed water.

Other papers dealt with pressure surges in pipelines carrying viscous liquids, and the application of internal-gear rotary pumps to viscous-liquid service. Five papers on fluid mechanics and three on prime movers rounded out the Hydraulic Division program.

Gas-Turbine Steam Power. The most provocative gas-turbine session was the one on combined-cycle gas-steam power generation in which P. F. Martinuzzi disregarded all work to date and looked ten years ahead to the possibility of making a single integrated unit that would operate on the combined cycle with all components optimized. He used the analogy of the race horse pulling a beer wagon to describe some of the unhappy results of merely combining available components. Although the authors who followed him on the program were apologetic for presenting "outmoded" material, they did mention that it was necessary to develop hardware for today's conditions. Z. S. Stys suggested in rebuttal that Dr. Martinuzzi would be trying to play the fiddle at the same time he was skiing if some of the combinations he proposed were adopted.

The same session also considered the complicated economics involved in adding combined-cycle units to accommodate system growth on a medium-sized system, and an alternative method of cycle improvement through heat recovery from the gas-turbine exhaust.

Installations in Other Countries. P. Chambadal of Electricité de France described that company's experiences with a number of gas-turbine installations. The company has regarded the gas-turbine installations as part of a developmental program to fulfill its research responsibilities, but operation with cheap fuel and reduced labor has brought these installations into the economically competitive range.

Other remotely controlled units were described from Arabia, Venezuela, and England. The Electricidad de Caracas unit is a fully automatic peaking unit for electric generation installed in a residential neighborhood and for that reason equipped with special silencers. Once the remote-start button has been depressed, start-up is fully automatic. Capital cost was $139 per kw but operation has been surprisingly cheap. The British remote-controlled unit is voice controlled over public-telephone circuits and has a series of recorded messages for reply to interrogation. It will also initiate its own telephone call if something goes wrong.

Operating experience was also described with two European steel-works plants, one in Germany the other in Belgium.

Marine Session. A marine session heard a 9000-hr-operation report on the Maritime Commission's vessel *John Sergeant*. Although the ship is now in "mothballs," it has demonstrated the practicability of operating a residual-oil-burning gas-turbine plant with two men per watch.

In addition to the combustion papers already referred to, and the fluid-mechanics approach to labyrinth-seal leakage, there was a metallurgical paper on the operating experience with Nimonic 80A first-stage buckets in natural-gas-burning turbines.

There were also papers on developmental experience with prototype gas turbines, on the application of gas turbines in industry, and on the single-shaft versus two-shaft gas turbine. Cooper Bessemer's new 10,000-hp gas turbine, Clark Brothers' 9000-hp single-shaft unit, and Solar's 1100-hp turbine for marine and land applications also were described.

Luncheons and Banquet

Harold Grasse, Vice-President of ASME Region VIII, in which the South Texas Section is located, delivered an address at the Welcoming Luncheon on "Truth or Consequences."

He asked if the antimissile, or the Dewline, or this or that missile was the only answer to the international situation. A Russian has stated that the "U. S. will be conquered from within"—by the very hysteria which it creates itself.

Other steam-heated, air-cooled, and wheeled-vehicle-driven civilizations—which even had easy credit systems—he stated, have failed in the past because their foundations rotted away and they taxed themselves out of existence.

The sorry conditions in this world today—the strife, the envy, the hatred—are not in the abstract or "over there somewhere," he said, but right here. Alluding to recent examples of religious bigotry, he said that we have the "guy who lives next door to me" type of problem, and human engineering may be the answer. The engineer's mind turned toward an understanding of the laws which govern human behavior may help us advance in our psychological state which now is just about where it was 2000 years ago.

He pointed out that we don't fear the laws of physics and chemistry even though they may lead to catastrophic results, because we know those laws and understand them. Isn't it possible that human behavior follows certain understandable laws also? Isn't truth the vaccine that can conquer the "fear virus"?

John H. Colby, chairman of the South Texas Section of ASME, was the toastmaster at the Welcoming Luncheon.

Hydraulic Division Banquet. W. V. Houston, president of the Rice Insti-

Gas Turbine Power Luncheon. Seated at the head table, **left to right,** J. L. Schweppe, Mem. ASME, chairman of the arrangement committee; Z. Stanley Stys, Assoc. Mem. ASME, GTP Division program chairman; R. Tom Sawyer, Fellow ASME, GTP Division treasurer; B. O. Buckland, Mem. ASME, GTP Division executive committee; J. H. Anderson, Mem. ASME, GTP Division chairman; ASME President Walker L. Cisler; T. J. Putz, Mem. ASME, manager of the gas turbine department, Westinghouse; Harold Grasse, Mem. ASME, Vice-President of ASME Region VIII; W. C. Osborne, Mem. ASME, Hydraulic Division program chairman; John H. Colby, Mem. ASME, chairman of South Texas Section.

tute, Houston, Texas, was the speaker at the Hydraulic Division Banquet. His topic was "Is Engineering an Appropriate University Subject?"

"Engineering today," he said, "is the application of science to practical problems. This involves an understanding of the science, and a skill in the application. The emphasis on the science has been increasing during the past decade. It is science rather than the application that has changed engineering so much in the past 20 years, and yet it has always been true that any fresh application of science to practical problems has been a major advance in engineering. I like to illustrate this point with incidents from the history of engineering."

A humorous treatment of Archimedes as "Director of the Office of Scientific Research and Development" for the kingdom of Syracuse during its two-year siege by the Romans followed.

Howard W. Emmons, Mem. ASME, professor in the Division of Engineering Sciences and Applied Physics, Harvard University, was toastmaster.

Gas Turbine Power Luncheon. "Power for an Expanding Economy" was the topic of ASME President Walker L. Cisler's address at the Gas Turbine Power Luncheon. Where there is an adequacy of power, he stated, there is an expanding economy.

He stated that there are four major imbalances affecting world conditions—population, resources, sources of energy, and utilization of energy. He gave examples of the way in which high-voltage transmission lines are helping to correct one of these by bringing power from the regions of production to the areas where it is required.

As an example of future possibilities, he cited the 25-million kw of firm power that are available at Inga in the Belgian Congo—whose size can be grasped when compared with our national total of 180 million installed kw. While too remote for transmission, there is the possibility of upgrading materials or of creating synthetic fuels through electrochemical processes.

There is a great future need for power, not only throughout the world but in the United States, Mr. Cisler stated. Through the development of power of all kinds, the engineer will be in a position to influence world affairs and to help mankind to a better understanding of world problems and a lessening of tensions.

Technical Papers

An availability list of papers presented at this meeting follows. Digests of all papers which are not scheduled for publication in MECHANICAL ENGINEERING will appear in the "ASME Technical Digest" in this or a forthcoming issue of MECHANICAL ENGINEERING.

Availability List—Joint Gas Turbine Power-Hydraulic Conference

THE papers in this list are available in separate copy form until January 1, 1961. Please order only by paper number, otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $3 to members; $6 to nonmembers.

Gas Turbine Power

60—GTP-1 Experiences With Gas Turbines in French Power Stations, by P. Chambadal

60—GTP-2 A Rapid Starting Automatic Gas-Turbine Generating Plant for Peak-Load Duty, by B. G. Markham

60—GTP-3 Three Years' Operating Experience With 7500-Kw Gas-Turbine Plants in Belgian Steelworks, by E. Aguet and J. Von Salis

60—GTP-4 Considerations for Gas Turbines and Their Initial Operating Experiences at El Convento, by O. H. Pfersdroff

60—GTP-5 Report on 9000-Hr Operation of Marine-Propulsion Gas Turbine in the *John Sergeant*, by H. D. McLean, C. C. Tangerini, and W. H. Van Cott

60—GTP-6 Gas-Steam Power Generation, by P. F. Martinuzzi

60—GTP-7 Smoke Reduction in Residual-Fuel-Burning Gas-Turbine Combustion System, by R. B. Schiefer, J. B. Gatzemeyer, and N. R. Dibelius

60—GTP-8 Operating Experience of Nimonic 80A First-Stage Buckets in Natural-Gas-Burning Turbines, by G. R. Heckman and A. W. Herbenar

60—GTP-9 Gas-Turbine-Exhaust Heat-Recovery Cycle, by G. L. Morris

60—GTP-10 The Behavior of Gas Turbine Combustion Chambers While Burning Different Fuels, by C. Kind

60—GTP-11 1100-Hp Gas Turbine for Marine Applications, by R. G. Mills and P. A. Pitt

60—GTP-12 A Fluid Mechanics Approach to the Labyrinth Seal Leakage Problem, by Géza Vermes

60—GTP-13 Development Experience With Prototype Gas Turbines, J. E. Cook

60—GTP-14 Operation and Maintenance of Remotely Controlled Gas-Turbine Units, by R. C. Hill, R. H. Hubbell, and M. L. Krapp

60—GTP-15 Economics of the Steam-Gas Turbine Exhaust-Fired Cycle for Medium-Size Utilities, by M. Eisler and W. M. Sybert

60—GTP-16 Operational Experience With a 15-Mw Gas-Turbine Generator in an Iron and Steel Works, by F. K. Konig

60—GTP-17 Comparison of Operating Characteristics of a Two-Shaft Gas Turbine With a Single-Shaft Gas Turbine for Gas-Line Pumping, by M. J. McDonough

60—GTP-18 Description of a 9000-Hp Single-Shaft Gas Turbine, by O. C. Schoeppner

Hydraulic

60—Hyd-1 The Application of Internal-Gear Rotary Pumps to Viscous Liquid Service, by S. L. Fry, R. J. Kinnavy, L. H. Kessler, and S. E. Kotz

60—Hyd-2 Pressure Oscillations in a Water-Cooled Nuclear Reactor Induced by Water-Hammer Waves, by P. Lieberman and E. A. Brown

60—Hyd-3 Accelerations and Mean Trajectories in Turbulent Channel Flow, by S. Irmay

60—Hyd-4 Reduction of Turbine Runner Vibration and Noise, by F. C. Taylor

60—Hyd-5 Pressure Surges in Pipelines Carrying Viscous Liquids, by W. T. Rouleau

60—Hyd-6 A Jet Pump Design Theory, by T. W. Van der Lingen

60—Hyd-7 An Experimental Study of Cavitation in a Mixed Flow Pump Impeller, by G. M. Wood, J. S. Murphy, and J. Farquhar

60—Hyd-8 An Effect of Air Content on the Occurrence of Cavitation, by J. W. Holl

60—Hyd-9 Experiences With Hydraulic Prime Mover Controls, by F. R. Schleif and L. M. Johnstone

60—Hyd-10 Selection of the Hydraulic Turbines for the Mammoth Pool Project, by H. E. Burrier

60—Hyd-11 Supersonic Diffuser for Radial and Mixed Flow Compressors, by F. Dallenbach and N. Van Le

60—Hyd-12 The Coring Phenomenon in the Flow of Suspensions in Vertical Tubes, by D. F. Young

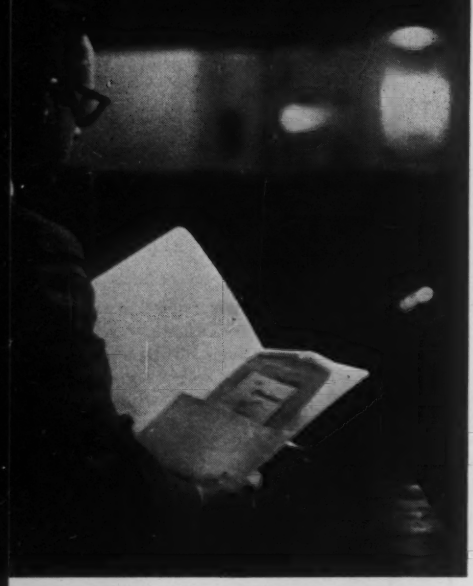
60—Hyd-13 Liquid-Metal Cavitation—Problems and Desired Research, by F. G. Hammitt

60—Hyd-14 Observation of Cavitation in a Low Hub-Tip Ratio Axial-Flow Pump, by M. J. Hartmann and R. F. Soltis

60—Hyd-15 The Correlation of Turbocompressor Performance With Various Gases, by C. A. Macaluso

60—Hyd-16 Two-Dimensional Flow With Standing Vortices in Ducts and Diffusers, by F. O. Ringleb

60—Hyd-17 Practical Stage Performance Correlations for Centrifugal Compressors, by F.J. Wiesner, Jr.



What's in the kit?

Committee Chairman H. A. Hartung makes the opening address

Meet the committee. Back row, **left to right**: W. J. Anderson, Chairman H. A. Hartung, W. A. Wright. Front row, **left to right**: R. Q. Sharpe, G. B. Grim. All are ASME members.

ASME Symposium on Load-Carrying Capacity of Bearings

THE THIRD annual ASME Spring Lubrication Symposium, held in New York City at the Engineering Societies Building on March 14 and 15, 1960, provided a forum for discussions of the factors influencing the load-carrying capacity of bearings. An audience of 129 engineers and scientists heard 11 technical papers and two panel discussions covering a number of aspects of this subject. The considerable discussion generated by these presentations attested to the interest in this subject and the need for broad dissemination of information along these lines.

These are essentially informal gatherings intended to bring out new data which, in many cases, have not been put in shape for publication. Those who attend receive the latest information and hear advanced discussion on topics that later will be formalized in the literature.

Of the four half-day sessions, the first was devoted to Design Parameters as related to rolling contact bearings. High lights of this session included a discussion by Burton of thermal and thermoelastic effects in these bearings, showing that interference can cause bearing failure, and relating the temperature of oil, balls, and races to the loss of clearance suffered. Zaretsky and Anderson described rolling contact fatigue studies in the spin rig and a new five-ball rig, using balls made of tool steels and crystallized glass ceramic. This latter material exhibited interesting properties which may make this class of compositions useful in very high temperature applications. Irwin related relative capacity, hardness, and operating temperature for a number of ball-bearing alloys.

The second session dealt with the effects of Application and Environmental Factors on the load-carrying capacity of sliding element bearings. Hull described a rotatable sleeve device for the control of oil whip in lightly loaded journal bearings. An important aspect of parallel-surface thrust bearing performance was discussed by Nahavandi and Osterle. These authors showed how axial vibration and wobble can produce substantial hydrodynamic forces, and can thus account for the observed load-carrying capacity of such bearings when there should theoretically be none. In discussing sleeve bearings, a panel covered the effects of lubricant temperature and pressure, contamination, bearing application, and vibrational disturbances on load-carrying capacity.

In Session 3 emphasis was placed on the Physical Properties of Lubricants. Dixon described the work of API Project 42, and what relations have been found between structure and the effects of temperature and pressure on viscosity. Wright showed how presently available data on the variation of viscosity with temperature, pressure, and shear can be used to arrive at reasonable estimates of these effects to cover many practical situations. Hartung outlined the problems associated with shear and time effects in lubricants and described a proposed ASME Research Program for elucidating some of the information needed to advance the state of lubrication theory and design practices.

The final session was devoted to the Chemical and Physical-Chemical Properties of Lubricants and their influence on load-carrying ability. Haltner presented results of a laboratory study of MoS_2, in which he showed that water and a number of organic vapors raise the friction coefficient between this solid lubricant and copper. The results with water were explained on the basis of reaction with MoS_2 to form H_2S, which could be detected. Surface temperature estimated from the chemical kinetics of this reaction checked very well with that obtained by flash temperature calculations. A general panel discussion on adsorbed and chemically active additive effects rounded out this session.

The technical sessions were held in the auditorium of the Engineering Societyies Building at 29 West 39th Street, among the last of such sessions to be held in the old building which has served the profession for over half a century. Opening date for the new Engineering Center at United Nations Plaza now is stated as August of 1961. Should the Lubrication Symposium of 1962 be held in New York, it would enjoy surroundings as modern as the advanced lubrication engineering.

Availability List—Lubrication

THE papers in this list are available in separate copy form until Jan. 1, 1961. Please order only by paper number, otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $3 to members; $6 to nonmembers.

60—LubS-1 Control of Oil Whip Frequency Ratio, by E. H. Hull

60—LubS-2 A Note on the Influence of Elastic Compliance on Sliding Friction in Ball Bearings, by K. L. Johnson

60—LubS-3 The Effect of Vibration on the Load-Carrying Capacity of Parallel Surface Thrust Bearings, by Amir Nahavandi and Fletcher Osterle

New Horizons for Experimental Investigation in the Mechanical-Engineering Curriculum

THE engineering laboratory plays a vital role in the training for professional leadership. The rapid changes occurring in science and engineering are now being reflected in major engineering curricular redesign. The most difficult aspect of curricular planning and execution is that which deals with laboratory education.

The conviction that a very strong effort must be directed to solving this problem on a nationwide basis stimulated the formation of an unofficial ad hoc committee for mechanical-engineering experimental laboratory instruction.

We live in an engineering world in which static conditions seldom prevail. And the design function of the mechanical engineer is far broader than the "design of machine elements" concept which formerly guided the thinking of many educators.

Further, mathematical analysis, a fine and necessary procedure in all phases of engineering, must be supplemented by experimental processes if the engineer is to extrapolate safely from the mathematical model to the actual conditions which prevail.

These factors stimulated the formation of an unofficial ad hoc committee originally made up of Richard G. Folsom, Fellow ASME, President, Rensselaer Polytechnic Institute; John A. Hrones, Mem. ASME, Vice-President, Case Institute of Technology; Norman A. Parker, Mem. ASME, Chairman, Department of Mechanical Engineering, University of Illinois; and Gordon B. Carson, Mem. ASME, Vice-President, The Ohio State University, acting chairman of the group.

An unscheduled meeting took place at the ASME Annual Meeting in Atlantic City in November, 1959. This meeting was exceptionally well attended, and those who were present urged the continuation of the Committee in expanded form. Action, not words, was the charge. "Obsolete cast-iron museums must go," was the theme.

Accordingly, the National Science Foundation, with Doctors Bowen C. Dees, Assistant Director for Scientific Personnel and Education; Arthur Roe, Head, Course Content Improvement Section; Richard E. Paulson, Assistant Project Director, Course Content Improvement Section; and Ralph H. Long, Jr., Engineering Sciences, spearheading the move, called a meeting in Washington, D. C., on Jan. 22, 1960, to plan the next best step.

At this meeting the steering committee was expanded to include Profs. James B. Hartman, Chairman, Department of Mechanical Engineering, Lehigh University; John F. Lee, Broughton Professor of Mechanical Engineering, and Head, North Carolina State College; and Newman A. Hall, Chairman, Department of Mechanical Engineering, Yale University.

With the advice of the steering committee, NSF sponsored a two-day conference in Washington, D. C., on March 25 and 26, 1960. This conference, attended by 37 invited members of mechanical-engineering faculties, included examination of several approaches to the solution of the problem of the experimental laboratory in the mechanical-engineering curriculum.

Two projects are now supported by NSF, under the direction of Professor Lee at North Carolina State College, and Professor Hartman at Lehigh University. These are, respectively, "A Study of the Course Content in Experimental Mechanical Engineering" and "The Development of Educational Aids in Mechanical Engineering," and represent two approaches toward a solution to the experimental laboratory problem, co-ordinated by a common advisory committee selected by the project directors to provide policy guidance and help in planning.

The NSF Washington Conference on the Mechanical-Engineering Laboratory arrived at several conclusions which will be explored further. Among these are the following:

- **Design must be tackled on a systems analysis basis in the advanced stages.**
- **Laboratory must become the experimental arm of regular courses taught by regular staff instead of a separate curricular entity, with a "laboratory staff."**
- **Routine testing esperiments must be replaced with fewer experiments of more comprehensive nature and greater challenge, resulting in a formal professional type of report.**
- **All forms of experimental endeavor must be used . . . . . demonstration . . . . . participation . . . . . individual student initiative in designing and conducting an experiment.**
- **Statistical validity in experimental processes must be covered thoroughly.**
- **Analogs of some phenomena appear to be the most desirable methods for experimental investigation.**
- **Old laboratory specialities may have to be abandoned for a more fundamental and yet broader consideration of phenomena involved in a given experimental investigation.**

The conference passed these resolutions unanimously:

"That the steering committee under the chairmanship of Gordon B. Carson be continued, with the privilege of calling further conferences, and that consideration be given to the employment of a full-time executive secretary to implement progress toward the complete integration of the experimental laboratory into the regular courses in mechanical engineering."

"That foundations be encouraged to support curricular introspection, such as that engaged in at the University of California, Los Angeles, in the individual departments of mechanical engineering throughout the country."

The steering committee enlarged by the addition of Professor Kenneth Wadleigh of the Massachusetts Institute of Technology will now take the following action:

1 Provide news releases covering work of the committee to date.

2 Establish a procedure for disseminating information on projects and action taken to improve the Mechanical-Engineering Experimental Laboratory program.

3 Investigate and stimulate the provision of Foundation support for a continued program of research and development in the Mechanical-Engineering curriculum.

4 Organize a smaller work conference on the Mechanical Engineering Experimental Laboratory in 1961 at which time the developments of the intervening period will be delineated, further solutions proposed, and a framework of action presented to all conferees.

1960 ASME Power Show

THE 24th National Exposition of Power and Mechanical Engineering will be held at the New York Coliseum November 28–December 2, and the official announcement reveals that a substantial amount of space has already been engaged in advance. The biennial display will be held under the auspices of The American Society of Mechanical Engineers in conjunction with its Annual Meeting.

This year's Exposition will disclose new developments in equipment for wholesale power generation and an equally important evolution of power applications in manufacturing and service industries.

Other displays will reflect recent revisions in the boiler and pressure vessel code as well as the revised standard covering pipe of steel, wrought-iron, carbon-steel, austenitic stainless steel and other alloys.

The Exposition continues to be under the management of the International Exposition Company, 480 Lexington Avenue, New York 17, N. Y.

Management (*Continued from page 121*)
Economic and Industrial Research, Arlington, Va., conducted a workshop in linear programming, while Frank Cable, Manager, Programming, Maintenance, Univac Division, Remington Rand Division, Sperry-Rand Corporation, New York, N. Y., played the Manufacturing Management Game with 60 early conference registrants.

Nuclear Power in the Sixties. At the Thursday Luncheon, the chairman was Hugh Bogle, supervisor of industrial engineering, E. I. du Pont de Nemours & Company, Inc. Main speaker was Walker L. Cisler, President of ASME and president and director of Detroit Edison, who spoke on the development of economic nuclear power.

Mr. Cisler pointed out that there were more than 132 electric power companies engaged in nuclear power projects, and that while the nuclear power plant must justify itself either in low cost or efficient operation, at present we must use it as a research tool. It will be several years before we have significant data. In its work with other nations, the U. S. Atomic Energy Commission has done much for international peace and understanding.

Honors. More than 900 attended the Friday Luncheon—again in the Grand Ballroom; the Chairman was Dause L. Bibby, SAM National President and executive vice-president of the Remington Rand Division, Sperry Rand Corporation. To Mr. Bibby fell the pleasant duty of presenting the Gilbreth Medal to Leo B. Moore, professor of industrial management at M.I.T.

Professor Moore—engineer, educator, author, and counselor—received the coveted award for a long series of accomplishments, notably "for vision as an industrial engineer to see in motion studies and the work of the Gilbreths the future potential of management by the same organized process; for his application of these same principles to military intelligence during World War II; . . . for his articles and lectures and their inspiration to managers, engineers, and students. . . . ."

The Materials Handling Award went to William Stanhaus, president of Spector Freight Systems, for his "efforts to provide more efficient material handling in trucking and motor transportation. Among the developments led by Mr. Stanhaus are containerization of freight, mechanized handling within the terminal, double-bottom trailer operations, and the relay method of moving freight with a minimum of lost time—and generally for the promotion of original research in this field.

Labor and Advancing Technology. Main speaker was James L. Young, vice-president, engineering, U.S. Steel Corporation, a major industrial executive in sales, research, and engineering. He gave the assemblage a hard look at the labor-cost situation of the next ten years, both from the national and foreign viewpoints.

Mr. Young, just back from a trip around the world, spoke on the labor implications of the world situation. He had traveled as one of a delegation representing the Iron and Steel Institute, studying the conditions surrounding steel production in the Far East. He reported, particularly, on India and Japan.

India first: There they are, with 400 million people inhabiting a country half the size of ours—and with 4 million sacred cows. Nineteen per cent of the people can read. A group of 300 people are running India today, excellent people trained in outside universities, mostly in England. A few of the 300 are definitely communists. India is a semisocialist state, with Nehru trying to get everything he can for his country.

Where does India impinge on us? That country produces the cheapest steel in the world. They have any quantity of raw materials, plenty of coal. Except for their transportation system—their railroad system must be expanded if steel production is not to be hampered—they are in a position to beat us in the steel markets of the world, if not in our own markets at home.

"Japan, on the other hand, is 100 per cent literate," Mr. Young reported, and added that in the villages of Japan there are television masts on almost every house.

"In a few years," Mr. Young said, "Japan will be the best-informed nation in the world. In spite of this good standard of living and high standard of education, they still can compete, even though they don't have raw materials. They, too, can undersell us in steel."

Thus Mr. Young made his point on the labor implications of the world's advancing technology. Our costs must be held down.

"Unless we can keep our prices down," he said, "where will we be in the world market, or even in our own market? The 1960's will be a period of real trial, a battle to keep ourselves in the forefront."

Managerial Control and Utilization of Engineering Manpower

The Engineering Management Division of the Pittsburgh Section of the ASME met on March 15, 1960, to hear Kenneth L. Minnick and Carrol T. Sinclair present their views on "Managerial Control and Utilization of Engineering Manpower."

Mr. Minnick, general supervisor, project engineering, U. S. Steel Corporation, spoke as a first-line supervisor. He pointed out that one of the primary responsibilities of a first-line supervisor is to encourage his engineering staff to generate ideas. This is accomplished by the development of mutual confidence. It is also aided by adopting a "hands-off" policy toward the details of each individual's work unless interceding becomes imperative to prevent a serious error. The first-line supervisor also helps by arranging for full clerical assistance and keeps his staff well informed. Mr. Minnick is also a proponent of putting ideas down in writing since this necessitates a more thorough consideration of the problem. It was his opinion that satisfaction was the best incentive toward the fullest utilization of engineering manpower.

Mr. Sinclair, executive vice-president, Emerson-Garden Utility Service Corporation, Pittsburgh, Pa., represented the senior executive's viewpoint. He started by describing the engineer as one with the ability to think, analyze, and get a solution. To obtain these engineers, the services of a Personnel Department were considered. While the current trend is to hire people fitting a job description, Mr. Sinclair warned against discarding a good man simply because he doesn't fit the existing job description.

A final opinion should be reserved until the conclusion of a personal interview. Commenting on turnover, Mr. Sinclair blames it against job dissatisfaction which may be prevented by the first-line supervisor. In conclusion, Mr. Sinclair stated that management wants an engineer to be a loyal, intelligent idea generator, and that the first-line supervisor is generally the key to success in developing such personnel.

Conducted for the National Junior Committee

J.R. BERENDES

JUNIOR FORUM

The Mechanical Engineer in the Missile-Satellite Field

By A. H. Murphy[2]

A MISSILE is a device for hurtling a warhead over a given distance and detonating same upon arrival at the intended target. A satellite is an object put into orbit for civilian scientific or military purposes. The engineer working in the missile-satellite field can find the stimulating challenge that all desire. In addition, this is an area vital to the defense of our country and any contribution is aiding the national security.

Missiles. Missiles are a long-lead time item but they must be developed in the shortest possible time. This desired contract-development span has given rise to a new type of engineer. Since time is at a premium, a research engineer is designated to bridge the gap between finding the basic theory and application to production usage. Here is a man disciplined in basic fundamentals who can work along side the scientist in performing experiments to advance the frontiers; yet he is well grounded in the practical applications—aware of the limitations of presently available equipment and knowing what now can be produced in quantity. This is not to say that the engineering developments of the past are passé, for they are as vital as the new concepts being put to use. Maybe an outline of a mythical missile program will explain the broad scope and the various disciplines necessary to fire one warhead at the intended target.

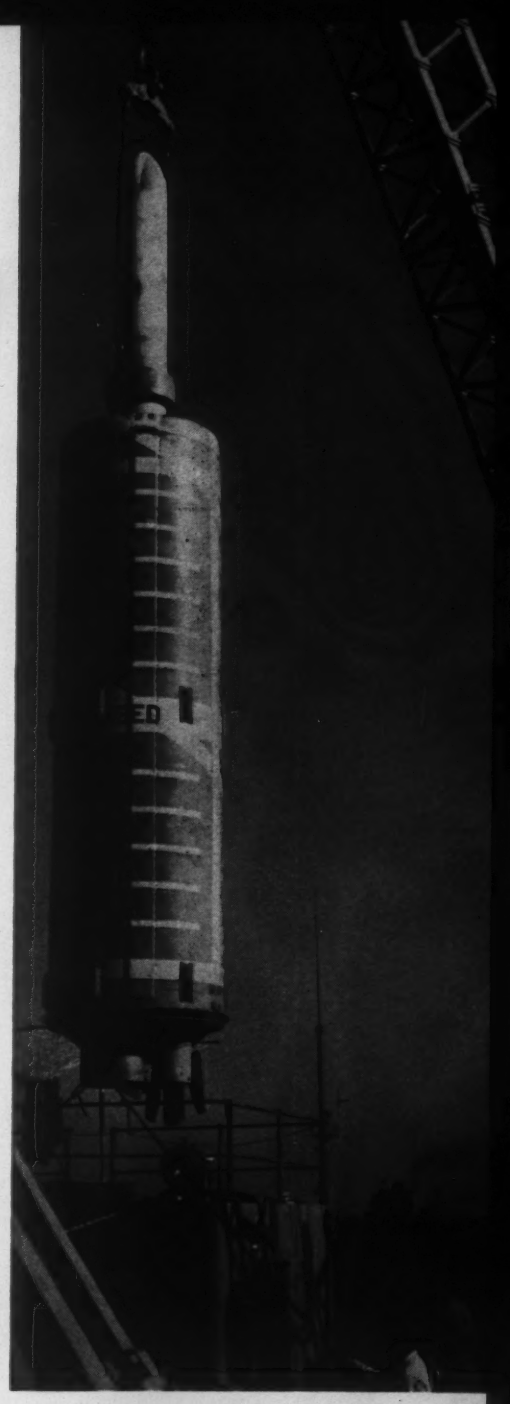
Mythical Missile Program. First of all, the military planners review the national defense/offense picture. A need for a particular type of missile is found. The requirements for which can have many sources—the need to kill an enemy's missile, the need to destroy an industrial complex, an army, a navy, an air force base, or personal weapon for the infantry. All the planners note is the need for a missile to perform certain political-strategic functions. Once the need has been established, the feasible missile requirements must be found. This is when the engineer enters the development. A feasibility study is undertaken.

The study can start out as a mathematical model of the probability of achieving the intended mission. When it becomes probable that the mission can be accomplished general requirement for the missile must be established. Such items as the kill radius for the warhead, the warhead size and weight, the type of fusing and firing device to be used, the shortest time and trajectory for delivery, the optimum guidance for accurate delivery, and so on. All must be determined on the basis of past performance, good engineering judgment, and the possibility of finding a break-through on some scientific frontier. The engineer plays an active role in the feasibility study, for it is he who knows practical shapes, sizes, weights, power, and system reliability that are probable of accomplishment.

Upon completion of the feasibility study a decision can be made by the military planners as to whether such a missile can be developed. If the answer is in the affirmative the program can begin. First, money is required; second, a producer; and third, development. A missile consists essentially of a warhead, a fusing system, a guidance package, and a motor. Check-out equipment and special test instrumentation must be developed. A missile system is not just the device itself but the logistics, ground support, firing sites, and other associated equipments. All the scientific disciplines are needed.

Mechanical Engineering. Mechanical engineering or the mechanically trained person is a vital member of the missile development team.

A supposedly new concept, reliability, or the full confidence that the intended mission will be accomplished has become



Polaris launch and training vehicle, nicknamed "Dolphin," is placed in submersible launching tube by Lockheed Missiles and Space Division technicians in preparation for underwater launch test at the San Clemente Island Sea range of the Naval Ordnance Test Station. The inert missile was designed by Lockheed to fill a vital spot in the development cycle of the Navy's 1200-mile, solid-fuel, submarine-launched ballistic missile: (1) To check all submarine launching systems before insertion of live missiles; (2) to train submarine crews in missile launching; and (3) to determine underwater trajectories of missiles in sea conditions ranging up to hurricane force.

[1] Sales Representative, Combustion Engineering, Inc., Chicago, Ill. Assoc. Mem. ASME.

[2] Senior design engineer, Lockheed Aircraft Corporation, Missile Systems Division, Sunnyvale, Calif. Assoc. Mem. ASME.

prominent in the missile field. Actually it applies mostly to the electrical/electronic black boxes. Mechanical structures have been checked for reliability. The reliability problem revolves around the extreme accuracy required and the desire to use parts that can be mass produced. Here is the challenge to make complex functions simple devices.

The motor and the warhead are designed by mechanical engineers. The guidance and fusing systems are basic electrical/electronic circuits but must be packaged by the mechanical engineer to withstand the rigors of the various environments to which they will be exposed. It is a process of design, build, and test—redesign, rebuild, and retest. Missiles are a process of evolution. The first designs on paper will not look like the finished product. The close proximity and interrelationship of parts is a cause of this development. A change in one part will effect others. Therefore the various fields of engineering work closely together.

Reliability. Reliability becomes an important factor. The test program is not so much to prove out the design as to afford a confidence level (reliability). The mechanical engineer is in great demand for this position in the missile program. The determination of when a part will fail, why it will fail, and what can be done to make it failproof are the reason for the (reliability) test and evaluation program.

When the design has been developed to the point where it is considered satisfactory to meet the requirement, production can begin. Missiles are produced in quantity and sent to the military for field evaluation. Here the check-out equipment is tested from a human engineering standpoint. What an engineer or technician who grew up with the missile system will do is not the same as what the military will do. At this time the missile system will have to be foolproof. After sufficient usage the missile will become operational and the missile program is complete.

The challenge is there, for often a specific break-through must be accomplished to achieve the desired missile performance. When development starts, all that is known, is that the scientific break-through is possible. The work is still to be done. Pushing the state of the art, finding simple structure or systems, is necessary. Testing and the proper evaluation based on good engineering judgment becomes a prerequisite. Time is always of the essence and often the feasibility study will overlap the development program, which will overlap the production, which will overlap the field evaluation, and so on and on. There is a challenge in being right the first time, since the second time may be too late.

The Challenge. The engineer entering the missile field has a wide range of opportunity. A challenge is ever present.

Do not be fooled though, it is not all excitement. The usual routine, the usual make, repeat, make, repeat pattern is followed. Break-throughs on scientific frontiers are not an every hour occurrence. Finding the key that unlocks the door and putting the discovery to practical use gives satisfaction in having participated. No one skill is required.

The compactness of the package, and the development time overlap make those involved aware of the necessity for combined efforts. New specialties are constantly being created. A new vocabulary and nomenclature are constantly being formed. Besides enhancing the individual; i.e., his engineering development, he is a vital part of our national security. Missiles are a definite part of our offense/defense strategy. Our national policy is based, in part, on our retaliatory power which is our missile arsenal. If we, as a nation, are to remain a world leader, then our defenses must remain strong. It is likely that a next war will be fought with brain power. America's engineering trained manpower will be supplying a portion of this necessary brain power.

Satellites. Satellites are similar to missiles from an engineering standpoint. The major difference is the one-shot nature of the orbiting vehicle.

There is much to learn, and vital work for the engineer. The old specialties are still present and the new ones call for the services of the mechanical engineer. Stagnation will not be known because missile changes are many. Remember the old cartoon—the picture of a missile blowing up on the launching pad and the engineer turning to no one in particular and saying, "Well, back to the drawing board."

ASME COMING EVENTS

May 17–19

ASME Production Engineering Conference, Hotel Schroeder, Milwaukee, Wis.

May 22–26

ASME Oil and Gas Power Conference and Exhibit, Muehlebach Hotel, Kansas City, Mo.

May 23–26

ASME Design Engineering Conference and Show, The Coliseum, New York, N. Y.

June 5–9

ASME Semi-Annual Meeting and Aviation Conference, Statler Hilton Hotel, Dallas, Texas

June 20–22

ASME Applied Mechanics Conference, The Pennsylvania State University, University Park, Pa.

June 27–29

ASME West Coast Applied Mechanics Conference, The California Institute of Technology, Pasadena, Calif.

August 15–17

ASME-AIChE Heat Transfer Conference and Exhibit, Statler Hilton Hotel, Buffalo, N. Y.

September 7–9

ASME Joint Automatic Control Conference, Massachusetts Institute of Technology, Cambridge, Mass.

September 15–16

ASME-AIEE Engineering Management Conference, Morrison Hotel, Chicago, Ill.

September 18–21

ASME Petroleum Mechanical Engineering Conference, Jung Hotel, New Orleans, La.

September 21–23

ASME-AIEE Power Conference, Bellevue-Stratford Hotel, Philadelphia, Pa.

October 9–12

ASME Rubber and Plastics Conference, Lawrence Hotel, Erie, Pa.

October 17–19

ASME-ASLE Lubrication Conference, Statler Hilton Hotel, Boston, Mass.

October 24–25

ASME-AIME Fuels Conference, Daniel Boone Hotel, Charleston, W. Va.

November 27–December 2

ASME Annual Meeting, Statler Hilton Hotel, New York, N. Y.

(For Meetings of Other Societies see page 110)

Note: Persons wishing to prepare a paper for presentation at ASME National meetings or division conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Price to nonmembers 50 cents; to ASME Members, free.

Engineering Index—1959 to Be Off the Presses in June

THE forthcoming Annual Edition of The Engineering Index—1959 will be ready for distribution in June, 1960. Advance orders are now being accepted because there is a limited edition of this important annual volume. Price: $70.

For more than 75 years The Engineering Index has served the engineering profession. It has been industries' authentic guide to the periodical technical literature. Today it stands unrivaled. Engineers consider it a vital part of their reference equipment. Librarians find it reduces their work of searching; government bureaus and educational institutions use it constantly. Industrial organizations subscribe to it regularly to keep their engineers enlightened concerning progress in their respective fields.

In no better way can the progressive engineer keep in touch with current developments and trends in all branches of engineering activity than through The Engineering Index. The annotated reference items published provide a comprehensive digest of the important information of technical, scientific, and economic problems as recorded last year in engineering magazines, special bulletins, and government reports gathered from all over the world.

This is the kind of information needed to keep in touch with all branches of technical research and current developments in all phases of engineering. The forthcoming volume will contain annotations on over 30,000 articles in 249 "fields of engineering interest." It will devote more than 100 pages to the list of authors covered in more than 1500 technical periodicals. It includes a list of these publications of engineering, scientific, and technical societies, engineering and industrial periodicals, and publications of government bureaus, engineering experiment stations, universities, and other research organizations. Not necessarily all articles in these publications are indexed, selection being made on the basis of articles dealing with the art and science of engineering.

The Engineering Index is located in the Engineering Societies Building at 29 West 39th Street, New York 18, N. Y. It is a nonprofit organization which works closely with The Engineering Societies Library.

ASME Textile Conference Held at North Carolina State College

THE 1960 Textile Engineering Conference of The American Society of Mechanical Engineers was held at North Carolina State College, Raleigh, N. C., March 31-April 1. The Conference was sponsored by the Society's Textile Engineering Division, with the co-operation of our Greenville, S. C., Section, Piedmont-Carolina Section, Eastern North Carolina Section, and the Southern Textile Association. More than 100 engineers attended.

There were three technical sessions encompassing six technical papers, and two panel discussions, one panel on engineering aspects in design of treatment plants, the other on the subject of spinning from sliver. In general, the papers and discussions covered two major areas: Advances in engineering as they pertain to the textile industry; advances in textiles as they pertain to the engineer.

Subjects treated in the technical papers were: Water resources and stream-pollution control, textile-waste treatment, natural gas in the textile industry, the simplification of maintenance records, textile automation, and trends in the production of continuous filament textured yarns.

On the evening of March 31, the Conference held a banquet at the Sir Walter Hotel at which Kenneth T. Knight, of William C. Olsen and Associates, served as toastmaster. The main speaker was John T. Caldwell, Chancellor of North Carolina State College.

April 1, the last day of the Conference, saw the opening of the Engineers Fair, sponsored by the Engineers Council of the School of Engineering, North Carolina State College. In addition to the Fair itself, the Textile School of the College was open for interested delegates.

Availability List—Textile Engineering Conference

THE papers in this list are available in separate copy form until Jan. 1, 1961. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $3 to members; $6 to nonmembers.

60—Tex-1 Maintenance Records Simplified, by J. H. Boddie

60—Tex-2 Textile Waste Treatment—What to Do About It, by J. L. Brown, Jr.

ACTIONS ASME EXECUTIVE COMMITTEE

A MEETING of the Executive Committee of the Council scheduled for Friday, March 4, 1960, convened with only President Cisler present. The other four members of the Executive Committee were unable to attend: T. J. Dolan and W. H. Larkin were prevented from reaching New York City by a severe snowstorm and H. N. Muller and R. B. Smith were out of the Country. Therefore President Cisler appointed L. N. Rowley and V. W. Smith to serve as members pro tem to transact business before the Executive Committee. In accordance with standard procedure, all recorded actions became final when approval was received from the members of the entire Council.

There were present: W. L. Cisler, President; L. N. Rowley and V. W.

Smith, Directors; H. J. Bauer, Assistant Treasurer; E. J. Schwanhausser, Finance Committee Chairman; F. B. Turck and Samuel Walker, guests; O. B. Schier, II, Secretary; T. A. Marshall, Jr., Senior Assistant Secretary; W. E. Letroadec, W. E. Reaser, S. A. Tucker, and J. D. Wilding, Assistant Secretaries; J. J. Jaklitsch, Jr., Editor; H. I. Nagorsky, Controller; and D. B. MacDougall, Associate Head, Field Service.

Board on Codes and Standards. Ad Hoc Committee ISO/TC11. The Council authorized the appointment of the following ASME members to serve on the Ad Hoc Committee in furthering the work of ISO/TC11 and to be under the direction of the Board on Codes and Standards: J. L. Menson, J. D. Andrew, Jr., E. O. Bergman, A. R. Gatewood, E. C. Corten, R. F. Miller, C. O. Myers, and C. W. Wheatley.

Board on Honors. Machine Design Medal. At its meeting on Dec. 3, 1959, the Board on Honors approved the requested revision of the Deed of Gift for the Machine Design Medal, dated Dec. 4, 1958.

Posthumous Awards. In a letter ballot, closing Feb. 15, 1960, the Board on Honors voted to change the appropriate paragraph in the Honors Manual to read as follows: "It is the policy of the Board not to award honors posthumously, but when a recipient of an honor whose selection has been approved by the Council dies before the award is presented, the award may be made posthumously."

1959 ASME Medal. In a letter ballot, closing Feb. 15, 1960, the Board on Honors voted to recommend to the Council that its action of June 15, 1959, "To award the 1959 ASME Medal to Martin Frisch, Fellow ASME, New York, N. Y.," be carried out by conferring the award posthumously. The Council voted to carry out the action.

Research. In accordance with the delegation of authority to the Board on Technology by the Council on Nov. 30, 1959, the following supplements to research agreements were signed by the Secretary:

1 Supplement No. 2 to 7SP-5, maximum amount to be paid research agency "shall be increased by $7500" from $20,000 to $27,500.

2 Supplement No. 4 to 7DP-9A, expiration date extended to Aug. 31, 1960, and the maximum amount to be paid is increased by $600 from $5000 to $5600.

3 Supplement No. 2 to 7DP-11 and 7DP-13, expiration date extended to Jan. 31, 1961, at an increase in cost of $1500, making a maximum of $4500.

Sections. Upon recommendation of Vice-President Dolan, Region VI, and with the approval of the Minnesota Section, the Council authorized the formation of the Southern Minnesota Group of the Minnesota Section with Headquarters City at Rochester covering the following counties: Fillmore, Mower, Freeborn, Fairbault, Martin, Olmsted, Dodge, Steele, Waseca, Blue Earth, Wabasha, Rice, and the City of North Mankato.

The Council, on recommendation of Vice-President Little, authorized the formation of the Tri-Cities Subsection of the East Tennessee Section with Headquarters City at Kingsport, Tenn., and comprised of the following counties in Tennessee: Sullivan, Washington, Johnson, Unicoi, Hawkins, Hancock, Hamblen, Green, Carter, and the City of Bristol, Va.

Acting on the recommendation of Vice-President Hahn, Region II, and Vice-President Marlow, Region III, and the approval of the Mid-Hudson and the Hudson-Mohawk Sections, the Council authorized the transfer of Greene and Columbia Counties in New York from the Hudson-Mohawk Section to the Mid-Hudson Section.

Upon receipt of the By-Laws and recommendation of their respective Vice-Presidents, the Council voted to approve the affiliations of the following local engineering groups with ASME Sections as listed: New Orleans with The Engineers Club of New Orleans, East Tennessee with the Technical Societies Joint Council of Oak Ridge, and Milwaukee with the Milwaukee Technical Council.

Distinguished Foreign Visitors Gift Book. The Council authorized the appropriation of $750 from the "A" Development Fund to underwrite a portion of the cost of reprinting Robert H. Thurston's translation of Sadi Carnot's book entitled, "Reflections on the Motive Power of Heat," for presentation to distinguished foreign guests as a memento of their visit.

United Engineering Center. The Secretary reported that intensive efforts are being made to exceed the ASME Member Gifts Goal of $800,000 by July 1, 1960.

The Council authorized the signing of contracts with IBM for date-processing equipment on a rental basis of $9660 per year and with Scriptomatic, Inc., for the purchase of addressing equipment and accessories at a cost of $18,000.

Engineers Joint Council. ASME Representative Report. V. W. Smith reported as follows on three items from the February 26 Meeting of the EJC Executive Committee: (1) It was recommended that Secretary of EJC be appointed annually; (2) George Holbrook was appointed to obtain an opinion from the Societies on the continuation of the Nuclear Congress; and (3) the first issue of the *Engineer*, the new publication of EJC, was mailed the week before.

Joint Awards. Washington Award. The Recipient of the Washington Award is Herbert Payne Sedwick, President, The John Crerar Library. Mr. Sedwick formerly was executive vice-president of the Commonwealth Edison Company.

Institution of Civil Engineers. Kelvin Gold Medal. The Institute of Civil Engineers has announced the 1959 recipient of the Kelvin Gold Medal to be Sir Geoffrey Taylor.

Austrian Architects, Consulting and Civil Engineers. The Council voted: (*a*) To send greetings to the Austrian Architects, Consulting and Civil Engineers on the occasion of their 100th Anniversary; and (*b*) to designate Honorary Vice-Presidents to attend the Congress as official delegates of the Society.

Certificates of Award. The Council authorized the preparation of a certificate of award for Lee L. Amidon who for 15 years served as Faculty Adviser to the South Dakota State College Section.

The Board on Public Affairs recommended, the President approved, and the Council authorized the preparation of a certificate of award for William C. Foster, retired chairman of the Board on Public Affairs.

Retired Section Chairmen for whom certificates of award have been prepared include the following 1958–1959 Section chairmen: Alvan L. Clark, Columbus; Charles F. Harrod, Fort Wayne; Richard G. Henneman, Iowa-Illinois; George C. Kinsman, Miami; George B. Germain, Minnesota; Walton Forstall, Jr., Pittsburgh; Merle E. Timmcke, Rock River Valley; Gilman L. Graves, Jr., Washington, D. C.; Dennis G. Jones, Westmoreland. Also the following chairmen of Subsections: Fred R. Bell, Jr., Gulf Coast, and Edward M. Marselli, Paducah.

Death. The Council noted with deepest sympathy the death of Charter Member Henry Marx on Feb. 9, 1960. The following attended funeral services as Honorary Vice-Presidents of the Society: W. C. Beckjord, W. C. Bissmeyer, Louis Polk, and W. W. Tangeman.

The Council also noted with deepest sympathy the death of Morris L. Cooke, Manager of the Society from 1914 to 1915, on March 5, 1960.

Appointments. Presidential. R. S. Stover, Feb. 19, 1960, NSPE annual meeting, Wichita, Kan.

Lillian M. Gilbreth and R. H. Bacon,

XII International Congress of Scientific Management, Feb. 22–March 4, 1960, Sydney and Melbourne, Australia.

E. J. Carraro, Washington Award Presentation, Feb. 29, 1960, Chicago, Ill.

Leo Blumberg, April 13, 1960, The Pennsylvania Military College, Chester, Pa., inauguration of the President.

Vice-Presidential. C. J. Eckhardt, Region VIII Publications Committee Advisory Member.

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC
[Agency]

THESE items are listings of the Engineering Societies Personnel Service, Inc. This Service, which co-operates with the national societies of Civil, Electrical, Mechanical, and Mining, Metallurgical and Petroleum Engineers, is available to all engineers, members or nonmembers, and is run on a nonprofit basis.

If you are interested in any of these listings, and are not registered, you may apply by letter or résumé and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 5 per cent of the first year's salary if a nonmember, or 4 per cent if a member. Also, that you will agree to sign our placement-fee agreement which will be mailed to you immediately, by our office, after receiving your application. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application to the employer and for returning when possible.

NEW YORK	CHICAGO	SAN FRANCISCO
8 West 40 St.	29 East Madison St.	57 Post St.

Men Available[1]

Chicago Office

Maintenance or Mechanical-Department Superintendent, BSME; 43; 18 years' broad experience in oil refining and heavy chemical-plant maintenance. Ability to work with people and control costs. Prefers South, West, or Foreign. Me-1071-Chichago.

Plant Engineer or Maintenance Engineer, BSME; 29; 11 years' experience in plant maintenance and construction engineering. At present responsible for plant engineering at meat packing firm, including supervision of 50 men. No preference as to location. Me-1072-Chicago.

Project Engineer, BSME; 38; five and one half years test and development of diesel and automotive gas-turbine engines; two years reliability and maintenance engineering in missiles and systems. Resident Detroit area. Prefers Midwest or West. Me-1073-Chicago.

Plant Engineer or Manager, BSME; 46; 25 years' experience in power and chemical plants as engineer and supervisory capacities. Fla. or East Coast. Me-1079-Chicago.

New York Office

Mechanical Engineer, ME, MS, single 29; three years' diversified experience in machine design, project engineering, chemical-plant installation and start-up, instrumentation. Desires a challenging position in research and development, design, production. Interested in getting things done. $8500. Location optional, except Northeast or Midwest. Me-811.

Plant Manager, BME; 40; 20 years' heavy manufacturing experience; strong on tooling, automation, methods, labor relations, cost control. Medium-sized plant mass producing stamped, die cast, automatic screw-machine parts, and assembly. New York City. Me-812.

Research Engineer, Applied Mechanics, MSME, industrial experience, 13 months; teaching experience, 27 months; research, 24 months. $7200. Location optional. Me-813.

Executive, BSME, MSIE, PE; 34; 11 years' varied experience as plant manager and sales manager. Industrial relations, manufacturing, development and teaching, proved record of accomplishment in both military and civilian electromechanical products, cutting tools and metalworking machinery. Primarily businessman and profit maker; excellent administrator and operations man. Fee paid positions only. Minimum $18,000, plus incentive. Prefer central N. J. Me-814.

Industrial Engineer (Staff or Plant), BSME, Industrial-engineering option. Wide variety of industrial-engineering duties at a level and with authority close to that of a plant industrial engineer; some direct supervision experience. Approximately $7700. Northern N. J. Me-815.

Mechanical Engineer, BME; seven years' engineering experience with electromechanical, hydraulics, ultrasonics, pneumatics; expert with all machine tools; understands mil specs; background experience in commercial products and design. $9500, minimum. Long Island or Metropolitan N. Y. Me-816.

Project or Contracts Manager, Plant Engineer; 41; over 20 years' engineering experience with strong mechanical background in mining, ore processing and petrochemical installations, papermills, plant mechanical maintenance, airbase, and general construction. Thoroughly competent in office management and field administration. Presently located in Europe as contracts manager at SAC airbase complex as prime contractor's representative. Very good Spanish. Prefers Europe, Latin America, or western U. S. Salary open. Me-817.

Mechanical Engineer, BSME 1952, interested primarily in research and development; eight years' experience in consumer products; i.e., air conditioners and appliances; component selection design, development, testing, etc. $8500. Location immaterial. Me-818.

Sales Engineer, BIE; 42; four years' mechanical and electrical engineering, eight years' technical selling of process-instrumentation controls and systems. Graduate engineer with professional license. Desires Southwest or Southeast. Me-819.

Plant or Maintenance Engineer; over 30 years in construction, maintenance, and operation of power plants and buildings. All utilities including HVAE. $9000. Eastern U. S. Me-820.

Development Engineering Manager, ME; 11 years design and development of special machines; plant, facilities planning; supervision and contact. Conducted material evaluation, automation feasibility programs. Full project and department responsibility. Extensive technical writing and liaison. Prefers Northeast quarter of U. S. Me-812.

Engineer-Administrator, BME, experienced in design, layout, preparation of specs for industrial facilities; contract administration for consulting (architect-engineer) firms. $10,000, minimum. Prefers East Coast. Me-822.

Mechanical Engineer, BSME, PE; graduate studies plus 11 years developing special automatic machinery, processing equipment, and pneumatic control system components. Strong in economic analysis, planning, and organization. Location and salary open. Me-823.

Executive Engineer, Canadian, mechanical engineering graduate 1941. Completed Engineering Articles in Europe. Extensive administrative and managerial training in Canada; seven and one half years as executive engineer on multimillion construction projects for government. Seven years' experience as senior engineer on oil-company operations in the Middle East. Desires to relocate in southern U. S. or abroad in a warmer climate. Me-824.

San Francisco Office

Project, Plant Engineer, ME, 27. Plant and project engineering in large chemical plant, staff functions; experience includes cost estimates and justification, design, selection, purchase and installation of new equipment; sketching, detail and specifying revisions, additions to existing facilities. $7800. Prefers San Francisco Bay area, Calif. Home: East. Se-1867.

Mechanical Packaging Engineer, Sales, 41, two years machine development, customer, plan production, sales for carton and container development. Five years design, plant and machine maintenance for aluminum foil rolling. One year maintenance, production, design for food company. One year draft, detail piping, machinery, tanks. $7800. Prefers San Francisco Bay area. Home: San Francisco Peninsula. Se-1438.

Maintenance Engineer, ME, 34, 13 years' experience in charge of maintenance for mining and smelting facilities, electrical equipment, power, electrical application. $9600. Any location. Home: Ariz. Se-1295.

Sales, Marketing, ME, 38. Many years experience design, sales of heating and ventilating, air conditioning, mechanical systems for process, industrial and commercial buildings, chem plants; also heat transfer, pumping. Salary open. Prefers San Francisco Bay area. Home: East Bay. Se-1839.

Sales, Application, ME, 51, 30 years' experience sales manager, design on pumps manufacture and distribution, chemical and petroleum plant design. Salary open. Any location. Home: Central Calif. Se-1780.

Construction, Plant Engineer, ME, 34. Prof. Regist., La. Ten years' intensive field engineering experience during construction of industrial plants. In addition to direct experience, can offer high degree of personal initiative and self-sufficiency. Desire opportunity in engineering management, administration. $9000. Prefers western U. S. Home: Calif. Se-1741.

Plant, Production Manager, ME, 41, prof. lic, Calif. 15 years' experience supervising manufacture of paper cups and containers, equipment design and development of machinery, plant maintenance, power plant for paper manufacturers, and converters. $10,000. Prefers West. Home: Mo. Se-1709.

Sales, Management. 56. Widely experienced in crane industry from top management down through sales and engineering. Will relocate and travel as required. Good health. Available now. $25,000. Prefers West, Midwest. Home: Wash. Se-1698.

Plant Engineer, MSME, 34. Research, development on high-speed rotating machinery. Facilities engineer on testing and refrigeration equipment. Total ten years' experience with solid academic background. $7200–9600. Prefers Philippine Islands, Home: Calif. Se-1697.

Mechanical Maintenance, Design. Me, 43, 12 years' substantial, diversified and progressively responsible mechanical-engineering experience, estimating, mechanical design, senior mechanical, senior maintenance supervision, and project engineer with major chemical and oil companies. $9000. Prefers Rocky Mountains, West Coast. Home: La. Se-1679.

Chief Designer, MSME, 35, ten years' experience in design of nuclear weapons, missiles, air conditioning, heat equipment, mechanical work on hospitals, theaters, dorms, boiler plants, airfield utilities, cold storage plant. $13,000.

[1] All men listed hold some form of ASME membership.

Prefers Pacific area. Home: Calif. Se-1397.

Power-Plant Engineer, ME, 45. Worked as test engineer in steam-electric power plant. Thoroughly familiar with steam-power-plant cycles and pneumatic combustion-control equipment. $7200 up. Prefers Calif., Southwest. Home: Calif. Se-1659.

Development Design, MSME equivalent, 31. Broad mechanical engineering education and management courses. Five years' experience, independent and practical worker. Experienced in design, develop of high-speed automatic products, and assembly machinery. Interested in research, development, design. $8000-$9600. Any location. Home: Calif. Se-1109.

Designer, ME, 40, prof. lic ME, Calif. Ten years design, calculate, stress analysis of centrifuges. Also one year design and manufacturing of diesels, design of pellet mills, draft airframes for airline company. $12,000. Prefers San Francisco Bay area. Home: San Francisco East Bay. Se-1289.

Marketing Manager, ME, 29. Eight years specialized work in marketing, promoting, selection, and application of pneumatic industrial equipment with internationally known pioneer in compressed-air equipment. $8400. Any location. Home: Canada. Se-1277.

Management-Development Engineer, MSME; 43; experienced in training engineers and scientist supervisors in effective program administration; proved project organizer, executive; successful assistant to director, R&D programs; know co-ordination of direct, support manpower, procurement, R&D contracts, test facilities, budgets, reporting, professional, scientific personnel. $15,000. Prefers Far West. Se-431.

Industrial Engineer, Bus. and Econ., 33. Four months managing industrial engineering, tool design, product standards for electric-equipment manufacturer. Three years industrial engineering, plant layout, methods, work measurement, material handling on food processing. Six years methods, cost estimates, cost control, plant layout for meat processor. $10,000. Prefers West, Midwest. Home: Ohio. Se-1646.

Positions Available

Chicago Office

Professor of mechanical engineering, PhD or equivalent, to teach on undergraduate and graduate level and for research in the general area of machine design. Areas of interest may include dynamics of machinery, vibrations, bearings, and lubrications, etc. $10,000–$12,000. Employer will pay fee. Ill. C-7736.

Industrial Engineers, graduate mechanical or industrial, to 40, with none to five years' experience in general engineering, i.e., methods, time study, costs, etc. Will work in field on methods, time studies, cost reduction, etc., within a 40-mile radius of Chicago. Will consider recent graduates for training. Must be U. S. citizen. Travel about 90 per cent of time; home every night. Car required. $6300–$12,000, depending upon experience, plus expenses for car and travel. Employer will pay placement fee. Position with a railroad. C-7964.

Chief Engineer, BSME or EE, 35-45, preferably recent small company experience, for special equipment design integrating electronics and mechanics in creation, engineering and fabrication of custom instrumentation applicable mainly in the field of component testing and quality control. Inventive nature, possibly holding patents in the field. Should be able to conceive an instrument or machine for its practical solution, thence supervise the project through engineering and fabrication. $9000–$10,000. Employer will negotiate placement fee. Mich. C-8005.

Project Engineer, BS or MS in agriculture or ME, to 40; for the design of agricultural or other mechanical equipment, as well as supervision of experimental construction, testing, and liaison during manufacturing. Need a creative self-starter; articulate and able to work well with production, sales, management, and customer groups. To $9240. Minn. C-8025.

Senior Project Engineer, BSME or equivalent, 30–45, five years' experience in the design and implementation of special purpose product tooling and equipment. Thorough knowledge of fabrication processes, including rolling, punching, breaking, slitting, and welding. Aluminum extrusion experience helpful. Will work with design and implementation of above for a manufacturer of a roof and deck steel. $9000–$10,000. Employer will negotiate placement fee. West Chicago suburb. C-8028.

Teaching Personnel, PhD in mechanical engineering, to teach in machine-design field. Rank and salary will depend on qualifications. Good opportunity for a man interested in developing graduate courses in this field in addition to some undergraduate teaching. Ohio. C-8017.

Additional listings of positions and men available are maintained in the offices of E.S.P.S. Direct inquiries to nearest office. A weekly bulletin of engineering positions open is available at a subscription rate of $3.50 per quarter or $12 per annum for members; $4.50 per quarter or $14 per annum for nonmembers, payable in advance.

Teaching Personnel for Applied Mechanics, PhD required, to teach applied mathematics or mechanics in engineering college. Will have one advanced undergraduate course plus graduate-level teaching. Open. Ohio. C-8042.

New York Office

Project or Development Engineer, Electromechanical, graduate mechanical, with electromechanical product design experience including considerable stress analysis to work in design and development of moderately complicated products. Minimum of five years' design experience plus at least two years' experience in engineering supervision. Salary open. Pa. W-8891.

Instructor for a Mechanical-Design Program; MS in engineering desired but will consider a BS with related experience. Mechanical-design program is one which trains draftsmen for tool industry. $6000–$6800 for academic year. Available Sept., 1960. Upstate N. Y. W-8887.

Quality-Control Engineer, engineering degree plus minimum of one year's experience in quality-control work. Will be responsible for quality assurance on raw material, in-process work, and finished material. Must be familiar with statistical sampling methods and have ability to initiate and conduct programs in quality control. To $9000. Pa. W-8868.

Professor, Mechanical, PhD preferred, with some R&D experience. Research interest essential but special field immaterial. Small, competent staff needs leadership. Mechanical-engineering chairmanship available to right man. Base salary, in $9000 range with opportunity for supplementary income. Private institution in southern New England. W-8861.

Mechanical or Metallurgical Engineers for line supervisory positions. Must have foundry background and be heavy on steel. (a) Quality-control manager. (b) Assistant general foreman in charge of cleaning room. (c) Assistant general foreman to run grey iron foundry. $7800–$10,800. Pa. W-8860.

Mechanical Designer to design complete air-conditioning, heating, plumbing, and service piping system. Layout and design process-piping systems from flow diagrams. Must have good understanding of this field and be a registered engineer or capable of being registered and willing to take registration exam. Good experience record in this type of work. Capable of heading up a group of men and directing detail design and be thorough in checking work. $8000–$10,000. Ga. W-8855.

Process Engineer, at least three to five years' experience in manufacturing and building of patterns and molds, plus some experience in good machine-shop and tool-processing practices, or equivalent experience at discretion of the writer. Will co-ordinate with design and tool-engineering departments, purchasing department, and company vendors, the needed tooling and processing of vendored parts, to produce to company machine-building schedules and engineering specifications with emphasis on molds, patterns, and special fixturing. To $9500. Upstate N. Y. W-8850.

Chief Quality-Control Engineer, engineering degree, to establish and organize a quality-control engineering group to be responsible for systems and procedures, designing quality-control plans for shop and inspection, and quality assurance, for metal-machining operations. Seven years' experience in quality control and allied fields, including two years' of quality control and supervision. Approximately $11,000. Mass. W-8844.

Engineers. (a) Manager, product-development engineering, graduate mechanical, electrical, chemical or ceramics, or physical chemistry, with considerable experience in resistors or other electronic components; vacuum systems, vacuum evaporation, resistive or semiconductive films; conductivity and modes of conductivity in films or solids with respect to pure and doped crystalline structures. Must have ability to conceive and implement new product innovations. (b) Manager, manufacturing engineering, graduate mechanical or industrial engineer, or machine design, with experience in machine shop, packaging machinery, conveyers, production ovens, mold design, to supervise and be responsible for the design and redesign of all automatic production machinery and mechanisms. Should have a solid background in the development and manicure of production equipment. Midwest. W-8842.

Engineers. (a) Estimator, equipment, general knowledge of estimating procedure, using established pricing information and/or vendor's quotations. Mechanical background as related to the plating and metal finishing field, or experience record in similar field. Must be able to work rapidly and accurately on diversified quotations, from resale items to manufactured items. $6000–$7000 a year. (b) Design Engineer, equipment, graduate mechanical, three to four years' experience background in special machinery design, similar to materials handling, automated conveyers, chemical equipment, etc. Should be able to follow new design projects from start to finish with a minimum of supervision. Knowledge of shop procedures necessary. $7500–$8500. Conn. W-8835.

Project Plant Engineer, graduate mechanical or electrical, minimum of two to eight years' experience in plant design, construction, or plant-engineering work. Experience in power and steam essential. Under direction, will be responsible for design, estimating, installation, and start-up of various plant projects. Professional engineering registration desired. $7200–$8400. Del. W-8824.

General Supervisor, Operations and Mechanical Maintenance, graduate mechanical or civil, experience in materials-handling field with conveyers, crushers, loaders, etc.; desirable experience as outside machinist in rigging or general construction; supervisory experience. Will co-ordinate and direct operations and maintenance of ore-handling system on a three-shift operation. Will be responsible for car dumper, primary and secondary crushers, belt-conveyer system, stock-pile, Sauerman scraper, rotary plow, and ship loader. Working knowledge of Spanish desirable. $11,088, to start. South America. F-8818.

Production Engineer, BSME, high-volume commercial television-radio experience in design and manufacturing. Will be required to overcome production problems of a mechanical nature; determine design feasibility of prototype models, and perform liaison on production floor. To $10,000. Company will negotiate placement fee. Central N. J. W-8816.

Management Development, graduate in business administration, personnel or industrial psychology, five years' experience with a manufacturing concern in planning, organizing, and conducting a variety of training programs as well as implementing a management-development program, including organization analysis and manpower planning. Should have ability to lead training conferences and to express self clearly and concisely, both orally and in writing. $9000. Ariz. or Fla. W-8814.

Engineers. (a) Chief manufacturing engineer, graduate or equivalent, with heavy and extensive experience with stampings, tooling, processing, and automation. Must have successful experience in directing department. To $10,000. (b) Quality-control engineer, graduate, minimum of three to five years' experience. Experienced in writing of inspection procedures, trouble shooting, and knowledge of gage design. Opportunity to work in all phases of quality control and to use and learn modern statistical techniques, including design of experiments and analysis of variance. To $7700. Stroudsburg, Pa., area. W-8812.

Mechanical Engineers. (a) Project engineer, BME, minimum of five years' experience with manufacturing company; knowledge of thermodynamics, fluid flow, and application of metals to high temperatures essential, for development and design of safety relief valves for industrial and nuclear application. $9500. (b) Mechanical engineer, BSME, minimum of three years' experience; opportunity in analytical and product design work on pressure and temperature-operated mechanical devices. $7300, minimum starting. Conn. W-8790.

Editor for a national trade publication, graduate mechanical or electrical, with three to five years' public-utility experience and/or writing experience. $10,000 up, depending upon experience and background. Ill. W-8788.

Maintenance Superintendent, Nitrate Mine, graduate mechanical engineer, good knowledge of electrical equipment; at least five years' experience in charge of electrical and mechanical maintenance at an operating mine. Will have complete charge of all operating maintenance, involving electrical shovels and draglines, 25-ton diesel trucks, air compressors, drills, electrical locomotives, crushers, screens, conveyers, etc. South America. F-8761.

San Francisco Office

Production Engineer, ME or ChE, five to ten years' experience in phosphoric and ammo-phosphate production. Must have knowledge of process, design, and operation of phosphoric and ammo-phosphates. Salary open. Central Calif. Sj-5201-R.

Mechanical Designer, graduate, 25–35. Five to ten years' experience in fertilizer or heavy chemical industry for design of piping-pressure vessels, mixing equipment, selection of conveyers, agitators, general processing equipment, for chemical plant from process-flow sheets. Salary open. Plant located near Fresno, Calif. Sj-5199-R.

Plant and Staff Engineer, ME, under 40. Well qualified in maintenance, procedures, new equipment, power, water, steam, and able to supervise some board work, prefer experience in the food industries; capability to assume complete responsibility in a 3-plant operation $7800–$10,200. San Francisco Peninsula. Sj-5197-R.

Sales Engineer. Graduate ME, good personality and appearance, preferably under 35 (will consider older man if he has excellent qualifications) to call on food-processing plants, chemical plants, and general industry to sell pumps and similar standard equipment. Salary and commission (about $8000–9000, and expenses). San Francisco Bay area. Sj-5191.

Designer, at least BSME (prefer graduate study) from accredited school and four years' design experience, 25–40. Must be strong in design and know machine-shop practices and materials. For design, supervision of draftsmen, assume project engineering responsibility for whole family of machines (electromechanical devices such as linear accelerators). Some radar background (military service), working with high-voltage transformers or high-voltage equipment or radiation lab experience would be helpful. $9000–$10,200 or better, depending on experience. San Francisco East Bay. Sj-5187.

Project Engineers, ME or CE, any age. Minimum ten years' experience in engineering and design of open hearths or Bessemer steelmaking plants. Develop basic engineering, drawings, diagrams, specifications, close liaison with client's representatives, develop schedule of design procurement and construction, requisitions for equipment, review plans and specifications, progress reports, budget and cost control, feasibility reports. $12,000–$15,000. Chicago or San Francisco Bay area. Sj-5036.

Engineers. (*a*) Junior and senior design engineers, MinE, CE, ME, or MetE degree. Require background in industrial design and drafting with previous experience in mining, milling, smelting, or refining plants, and facilities desired. Applicants for positions at junior level especially desired, but some seniors. $7200–$10,200. (*b*) Construction engineer, graduate CE or ME, experience in all phases of plant construction, preferably in mining or mineral industry. $7200–$8400. Headquarters: Utah. Sj-5174-R.

Industrial Engineer, should be IE or equivalent, to 40. Solid background in cost control, manufacturing production, methods and process, and strong on inventory and inventory controls. Experience with electrical components desirable, but not required. Should be qualified in all respects (technical, supervisory, and potential for advancements). To fill such position for semiconductor manufacturer. $10,000–$20,000. Southern Calif. Sj-5160.

Chief Engineer, Design, Estimate, ME, CE, or equivalent, under 50. Well experienced in preparing complete industrial layouts; structural experience desirable. Knowledge of feed, flour, fertilizer, and chemical industries desirable; capable of handling design, selection, and purchase of machinery, equipment, and materials; field supervision, estimating costs and contract, and negotiate with clients. For long-established small firm of industrial engineers and contractors. $10,000 potential. San Francisco headquarters. Sj-5136.

Mechanical-Engineering Teachers, needed in fluids, heat transfer, thermodynamics, aerodynamics in theoretical and applied mechanics area. Large and rapidly growing graduate program through DS sponsored research encouraged.

Keep Your ASME Records Up to Date

The ASME Secretary's Office depends on a master membership file to maintain contact with individual members. This file is referred to countless times every day as a source of information important to the Society and to the members involved. All other Society records are kept up to date by incorporating in them changes made in the master file.

The master file also indicates the Professional Divisions in which members have expressed an interest. Many Divisions issue newsletters, notices of conferences or meetings, and other material. You may express an interest in the Divisions (no more than three) from which you wish to receive any such information which might be published.

Your membership card includes key letters, below the designation of your grade of membership and year of election, which indicate the Divisions in which you have expressed an interest. Consult the form on this page for the Divisions to which these letters pertain. If you should wish to change the Divisions you have previously indicated, please so notify the Secretary.

It is highly important to you and to the Society to be certain that our master file indicates your current mailing address, business or professional-affiliation address, and interests in up to three Professional Divisions.

Please complete the form, being sure to check whether you wish mail sent to your residence or office address, and mail it to ASME, 29 West 39th Street, New York 18, New York.

Please Print

ASME Master-File Information

Date

LAST NAME | FIRST NAME | MIDDLE NAME

POSITION TITLE | NATURE OF WORK DONE
e.g., Design Engineer, Supt. of Construction, Manager in Charge of Sales, etc.

NAME OF EMPLOYER (Give name in full) | Division, if any

*☐

EMPLOYER'S ADDRESS | City | Zone | State

ACTIVITY, PRODUCT, or SERVICE OF EMPLOYER; e.g., Turbine Mfrs., Management Consultants, Oil Refinery Contractors, Mfr's. Representative, etc.

*☐

HOME ADDRESS | City | Zone | State

☐

PRIOR HOME ADDRESS | City | Zone | State

* CHECK "FOR MAIL" ADDRESS

I subscribe to

Address changes effective when received prior to:

- ☐ MECHANICAL ENGINEERING — 10th of preceding month
- ☐ *Journal of Engineering for Power*
- ☐ *Journal of Engineering for Industry*
- ☐ *Journal of Heat Transfer* — 20th of preceding month
- ☐ *Journal of Basic Engineering*
- ☐ *Journal of Applied Mechanics*
- ☐ *Applied Mechanics Reviews* — 1st of preceding month

Professional Divisions in which I am interested (no more than *three*) are marked X.

- ☐ A—Aviation
- ☐ B—Applied Mechanics
- ☐ C—Management
- ☐ D—Materials Handling
- ☐ E—Oil and Gas Power
- ☐ F—Fuels
- ☐ G—Safety
- ☐ H—Hydraulics
- ☐ I—Human Factors Group
- ☐ J—Metals Engineering
- ☐ K—Heat Transfer
- ☐ L—Process Industries
- ☐ M—Production Engineering
- ☐ N—Machine Design
- ☐ O—Lubrication
- ☐ P—Petroleum
- ☐ Q—Nuclear Engineering
- ☐ R—Railroad
- ☐ S—Power
- ☐ T—Textile
- ☐ U—Maintenance and Plant Engineering
- ☐ V—Gas Turbine Power
- ☐ W—Wood Industries
- ☐ Y—Rubber and Plastics
- ☐ Z—Instruments and Regulators

No limitations on rank. Salary and rank commensurate with educational background and experience. Southwest. Sj-5119-R.

Mechanical, Industrial Engineers, recent graduates, up to two years' experience with primary interest in sugar industry, military completed. Assigned to plants for training period, then work in head office in engineering department (not on board), supervise draftsmen in groups of 3 in project design, work with contractors for plant expansion, plant improvement, and supervise design. Employer pays placement fee. Salary commensurate with qualifications. Headquarters, San Francisco. Sj-5154.

Project Planning, ME, ChE, under 40. Eight to 15 years' experience relating to determining scope, limits, layout, budgeting, progress. For a central engineering department involved in pulp, paper, waste paper, product and mill facilities. Able to deal with consultants, plant managers and engineers, contractors. Project from conception to completion. $8400–$9600. San Francisco East Bay. West Coast men preferred. Sj-5148.

CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

THE application of each of the candidates listed below is to be voted on after May 25, 1960, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and Transfers

Alabama

CAMPBELL, JAMES M., Mobile
COX, CHARLES D., Huntsville
DELLENBACH, WILLARD C., Birmingham
EARTHMAN, WILLIAM B., JR., Mobile
GATHRIGHT, EUGENE L., Scottsboro
GIBSON, ADOLPHUS H., JR., Birmingham
●MURPHREE, JOHN R., Birmingham
STANDROD, SAMUEL E., JR., Mobile
WILSON, R. BATES, Birmingham

Arizona

JOHNSON, RICHARD L., Phoenix

Arkansas

ROZZELL, GEORGE M., JR., North Little Rock

California

CIZEK, DONALD F., Canoga Park
DEAN, WILLIAM L., Sherman Oaks
DRISKEL, DAN, Corona del Mar
ECKERLING, HERBERT, Van Nuys
FARAH, NAZIH F., San Mateo
FISHER, COLIN R., Walnut Creek
GEORGE, ELLIS P., Mt. View
JOHNSON, MAURICE V., JR., Ontario
KOTT, EDWARD G., San Carlos
MCKAY, JAMES P., Oakland
RUBIN, MARTIN A., Los Angeles
SILVERBERG, SAM, Eastview
SOTER, GEORGE E., Long Beach
SUVERKROP, LEW, Bakersfield
●WRIGHT, REED M., Long Beach

Connecticut

APPLEGATE, RUSSEL C., Stratford
CURELLO, GENE, Hamden

Delaware

●STROUD, MACON G., Wilmington
UTLEY, CHARLES O., Newark

District of Columbia

SHAH, NALIN H., Washington

Florida

KENLY, ARNOLD N., St. Petersburg
SCROGIN, ETHELBERT D., Miami

Georgia

KROL, JOSEPH, Atlanta

Hawaii

●WALDEN, ROBERT F., Honolulu

Illinois

●BLAIR, JOHN E., Park Forest
●CLEMENS, JACK R., Glenview
HELLWIG, GORDON C., Glen Ellyn
HENNEMAN, RICHARD G., Rock Island
INDECK, ALBERT W., Glencoe
KRIKAU, FREDERICK G., Chicago
LIS, STEPHEN J., Niles
MURDOCK, WILLIAM E., Wheaton
PFITZENMAIER, RICHARD H., Chicago
●SAHLSTROM, ROY, Elmhurst
WINTER, SHEP, Northbrook

●Transfer to Member or Affiliate.

Indiana

REDMAN, JAMES E., Kokomo

Kansas

BRYANT, EVERETT P., Wichita
●FINUF, WILFRID B., Wichita
MORROW, WILLIAM D., Bethel

Louisiana

JOHNSTON, WILLIAM H., New Orleans

Maryland

CHENOWITH, PAUL E., Baltimore
MAY, THOMAS H., Severna Park
WATSON, ALVIN B., Catonsville

Massachusetts

BERRY, JOHN, JR., Brockton
BOWMAN, WILLIAM J., Dedham
GREEN, ROBERT M., Foxboro
HASTINGS, RAY J., Boston
KENSON, PAUL C., JR., Hingham
MOREL, ROGER E., Northboro
SHENKMAN, SEYMOUR M., Newton Center

Michigan

DUGGAR, ANDERSON, JR., Royal Oak
ET-TAHER, ABDER R., Ann Arbor
FERGUSON, ROBERT J., Benton Harbor
●GUNSAULUS, ROBERT K., Pleasant Ridge
LEVIT, EDWARD C., Jackson
MARTIN, LYNN A., Royal Oak
MICKUS, FELIX, Flint
OBERSCHULTE, RICHARD H., Detroit

Minnesota

AUSTIN, AVERY J., Hopkins
●RUDNICKAS, VITTE W., Rochester

Mississippi

HAWLEY, CURTIS F., Jackson
JOHNSTON, ARCHIE L., JR., Corinth

Missouri

COWGILL, THURSTON, St. Louis
MCGILL, HUGH B., Kansas City
WRIGHT, WALLACE B., St. Louis

New Jersey

BIRDSALL, BLAIR, Trenton
CONOVER, GEORGE R., Hazlet
EDWARDS, DONALD V., Montclair
GROESBERG, SANFORD W., Hoboken
●MCNEAL, JAMES K., 3RD, Woodbury
YOCUM, CHARLES W., Flemington

New Mexico

GRAHAM, ROBERT A., Albuquerque

New York

BELL, FRANK I., JR., Great Neck
BISCARDI, LOUIS E., JR., Kingston
BOOKER, JOHN F., Ithaca
BUONOCORE, SALVATORE, Syracuse
CALICCHIA, RICHARD, Rome
●CANTWELL, THOMAS W., Jackson Heights
CONROY, GERARD L., Buffalo
EBELING, DOLPH G. P., Schenectady
EBERLE, JAMES W., Schenectady
GADDIS, M. FRANCIS, Port Washington
HOLBROOK, JOSEPH F., Brooklyn
KARNKOWSKI, TADEUSZ, New York
KIESEL, BERTHOLD, New York
LIEDELL, JAMES E., Schenectady
●MAJORS, GLEN M., Painted Post
●MANGER, PAUL A., Eggertsville
MELLGREN, LEONARD P., New York
PAUL, FRANCIS G., Poughkeepsie
PAVONE, ROBERT J., Jackson Heights
SCHIZAS, ANDREAS M., Flushing
SHERK, WILFRID K., Niagara Falls
WEINHAUER, HAROLD F., Wellsville
WILLIAMS, DAVID H., JR., Port Washington

North Carolina

NEIGHBOUR, OREN J., Winston-Salem

Ohio

ARKINS, LEO P., Niles
●BLANTON, JAMES O., Cincinnati
●BOECKER, FRED, JR., Bay Village
BURGGRAF, FREDERICK, Cincinnati
FOSTER, TRUMAN G., Columbus
HARTWICK, WILLIAM F., Mount Vernon
HUBER, DIETER D., Cleveland
JONES, EDMUND D., Poland
MCCORMICK, WILLIAM S., Cuyahoga Falls
MILLER, WILLIAM N., Canton
RAY, EDWARD, Cleveland
ROBINSON, PAUL W., E. Cleveland
SCHMIEL, HERBERT H., Cleveland
SEEH, RALPH W., Kent
SZANCA, EDWARD M., Maple Heights

Oklahoma

HOWE, RICHARD J., Tulsa
●STRICKLER, ELMO E., Bartlesville

Oregon

MATUSZAK, JOHN M., Salem

Pennsylvania

ADAMS, DONALD W., Bryn Mawr
AUSTIN, RICHARD M., Philadelphia
BOCHNAK, VINCENT E., Morrisville
●BRUSCHINI, ALBERT, Easton
CODER, CHARLES H., JR., Lewisburg
●COHEN, LEONARD, Philadelphia
COLBY, JOSEPH M., Pittsburgh
COURSEN, RICHARD C., Yardley
DIPALMA, RONALD A., Philadelphia
HUNTER, DONALD, Pittsburgh
●MYERS, CHARLES H., Pittsburgh
●ROSS, FRANK A., Pittsburgh
SAMS, RAYMOND D., Lititz
●STAHL, WILLIAM F., Media
●STEPHEN, JOHN E., Devon

South Carolina

IKRAMULLAH, SAIYID A., Clemson

Tennessee

FERGUSON, JACK A., Maryville
HUDSON, JOHN C., JR., Whitehaven
●MAGETTE, EUGENE E., Chattanooga
●RING, FRANK, JR., Loudon
ROBERTS, JOHN D., Oak Ridge
●SCHONHOFF, CLEM C., New Johnsonville
●THOMAS, RALPH W., Chattanooga
VINSON, JAMES W., Kingsport

Texas

BLAKENEY, SAMUEL W., Baytown
BURNS, BENNETT W., Houston
BURROUGHS, WILLIAM F., Houston
FOWLER, JAMES E., Houston
FRUGE, BENNETTE B., JR., Fort Worth
GORMLEY, JOHN F., Houston
GRISSOM, FRED E., Texas City
JOPLIN, JOHN L., Houston
JUNEK, CLIFTON J., Houston
SANDERS, WILFRED E., Houston
●SPENCER, THOMAS M., Amarillo

Virginia

HUFFMAN, PAUL D., Fairfax

Washington

BRUNS, DONALD L., Seattle
●MARINOS, DANNY, Kennewick
●PERRAULT, RICHARD E., Seattle
THORNE, WAYNE L., Kennewick
●WATSON, DANIEL F., Pasco

West Virginia

FLATHMANN, JOHN H., JR., Charleston

Wisconsin

EDWARDS, THOMAS G., JR., New Berlin
MITCHELL, PAUL D., Beloit
SETER, PETER K., Milwaukee
SPAFFORD, BENJAMIN W., Beloit

Foreign

BALSYS, LEOPOLD, DON MILLS, Ont., Canada
BANERJEE, SUDHIR K., Bombay, India
GRIFFITHS, THOMAS H., Kirkuk, Iraq
●HOGAN, WILLIAM J., Adaban, South Iran
KELLY, ALPHONSUS G., Bray, County Wicklow, Ireland
KEMP, RAYMOND P., Toronto, Ont., Canada
LAMB, THOMAS A., Coupar Angus, Perthshire, Scotland
LOPEZ, ROBERTO S., Mexico, D.F., Mexico
LYNCH, THOMAS A., Harpenden, Herts, England
MCCAIG, IAN W., Niagara Falls, Ont., Canada
ROBERTS, GWYNFRYN, Glam, Great Britain
●RUITER, JOHANNES L., Taylor, B. C., Canada
SINGH, BAL RAJ, Near Calcutta, India
SINHA, BENOY, Patna, Bihar, India
SMIT, GERRIT, Maracaibo, Venezuela
SONI, MURLIDHAR, Bhilai, India
UITERWIJK, JAN H., Maracaibo, Venezuela

OBITUARIES

Henry Bartlett (1864-1960), retired civic leader and one of the ten oldest living graduates of Harvard College, died at his home in Cambridge, Mass., Jan. 30, 1960. Born, Lowell Mass., March 29, 1864. Parents, Charles E. A. and Harriet (Cooper) Bartlett. Education, AB, Harvard College, 1885. Married Alice Moulton (dec. in July, 1956). Mr Bartlett served an apprentice course in mechanical engineering with the Pennsylvania Railroad. In 1895 he was employed by the Boston and Maine, where he spent the greater part of his working life, and rose to the office of general mechanical superintendent. In 1918–1919 he was called to Washington to be a member of the Mechanical Committee of Railroad Standards of the U. S. Railroad Administration and became chairman of the Engineering Committee on Design of the U. S. Standard Locomotives for the first world war. He joined the Baldwin Locomotive and Standard Steel Works, serving in the London office from 1919 to 1920; he was made New England manager 1921 and continued until 1926. From 1928 to 1939 he was engaged in trustee work in the Boston area. Mem. ASME 1897; he held a 50-year membership medal from the Society. Member of Harvard and Cambridge Clubs. His daughter, Harriet M. Bartlett, is his sole survivor.

Edward Lull Cochrane (1892-1959), retired Vice-Admiral, U. S. Navy, and vice-president for industrial and governmental relations, M.I.T., died in New Haven, Conn., Nov. 15, 1959. Born, Mare Island, Calif., 1892. Parents, Brig. Gen. Henry Clay (U. S. Marine Corps) and Elizabeth (Lull) Cochrane. Education, attended Univ. of Pennsylvania, 1909–1910; SB, with distinction, U. S. Naval Academy, 1914; postgraduate, 1916; MS, M.I.T., 1920; attended U. S. War College, 1939. Married Charlotte Osgood Wilson, June 3, 1916; children, Richard Lull, Commander, U. S. Navy; Edward Lull, Jr., Lieut., U. S. Navy. Admiral Cochrane's naval career was spent primarily in design and supervision of repair and construction of naval vessels. His more than 20 years of specialization in submarine and general ship design was culminated by five years service as Chief of the Bureau of Ships of the U. S. Navy, from 1942 to 1947, when he was responsible for design and construction of the largest force of naval vessels our country has known. He had served as Chairman of the Federal Maritime Board and as Maritime Administrator in the Department of Commerce. In 1946–1947 he was chief of the Material Division, Office of the Secretary of the Navy. Special assignments included that of assistant naval attaché at London, 1940–1941, and membership on President Truman's Advisory Commission on Merchant Marine, 1947. He was professor of naval construction, head of the department of naval architecture and marine engineering, M.I.T., 1947–1950, and dean of engineering at M.I.T., 1952–1954. Awards to Admiral Cochrane include the Mexican Campaign Medal; Victory Medals of World War I and II; National Defense Medal; American Defense Medal; Asiatic-Pacific Campaign Medal; American Theatre Medal; David W. Taylor Medal, the nations highest award for notable achievement in naval architecture and marine engineering; the Navy's Distinguished Service Medal; and honorary Knight Commander of the Military Division of the Order of the British Empire. His honorary degrees include LLD, Hahnemann Medical College, 1943; ED, Polytechnic Institute of Brooklyn, 1946, and Stevens Institute of Technology, 1954; and SD, Tufts College, 1950. Hon. Mem. ASME, 1953. He was past-president of the Society of Naval Architects and Marine Engineers; fellow of the American Academy of Arts and Sciences; hon. mem. of the British Institute of Naval Architects and British Institute of Marine Engineers; member also, U. S. Naval Institute.

Joseph Lloyd Cottrell (1905-1959), president, Flow Measurement Co., Inc., Tulsa, Okla., died Feb. 27, 1959. Born, Plymouth, Ill., April 10, 1905. Education, high-school graduate, 1923. Mr. Cottrell's career was spent in the gas industry beginning with the Union Gas System, Inc., Independence, Kan. He was with the Pittsburgh Equitable Meter Co. (now Rockwell Mfg. Co.), Pittsburgh, Pa., until 1953. He wrote articles for *Oil and Gas Journal*, *Petroleum Engineer*, and *Gas Magazine*. Mem. ASME, 1954. Member also, Instrument Society of America, The Engineers Club of Tulsa The Nomads, the American Gas Association, the American Petroleum Institute, Southern Gas Association, The Mid-West Gas Association, Southern California Meter Association, and Natural Gasoline Supply Men's Association.

Cleon C. Dodge (1914-1959), sales engineer, M. H. Treadwell Co., died Jan. 4, 1959. Born, Washington, D. C., June 18, 1914. Parents, Cleon O. and Effie (Carter) Dodge. Education, BS, M.I.T., 1937. Assoc. Mem. ASME, 1937. His wife, Mary Louise E. Dodge, survives him.

Reid Earnhardt (1923-1959), research engineer, explosives department, E. I. du Pont de Nemours & Co., Gibbstown, N. J., died in the Hospital of the University of Pennsylvania, Aug. 6, 1959. Born, Annapolis, Md., March 26, 1923. Parents, Edwin Shell and Gladys (Reid) Earnhardt. Education, BS(ME), Cornell Univ., 1944; MA(ME), Carnegie Inst. of Tech., 1948. Married Ann Bridgwater, 1947. Assoc. Mem., ASME, 1948. His wife and three children, Samuel R., Ruth H., and Steven L. Earnhardt survive him.

Albert William Geiger (1895-1959), mechanical engineer, Morgan Engineering Co., Alliance, Ohio, died Aug. 31, 1959. Born, Philadelphia, Pa., Feb. 28, 1895. Parents, John A. and Meda Geiger. Education, evening school and Columbia Correspondence School. Married Miriam M. Slack, Aug. 27, 1913. For many years Mr. Geiger was with The Baldwin Locomotive Works, Eddystone, Pa., where he was responsible for engineering production and design of mechanical section of diesel locomotives. Mem. ASME, 1946. Surviving are his wife, and two daughters, Miss Marnie S. Geiger, New York City, and Mrs. Louis M. Gabel, Portland, Ore.

Nathan Henry Gellert (1889-1959), executive partner, Gellert, Griffin, Williams & Associates, Seattle, Wash., died in Nov., 1959. Born, Baltimore, Md., Sept. 7, 1889. Parents, Horace and Minna (Goldman) Gellert. Education, BA, PhB, CE, Yale Univ. Married Edna Louise Smith, June 18, 1912, (dec.); children, N. Henry, Jr., Eleanor L., Helen Elizabeth, and Edward B. Married 2nd, Georgia Marrs Barber, March 12, 1954. Mr. Gellert had a long career with various gas companies, starting as a cadet engineer with the Philadelphia Suburban Gas and Electric Company, Chester, Pa. He was chief engineer for Key West Gas Co. and Public Service Construction Co.; a consulting engineer; president of National Public Utilities Co.; president of Great Lakes Utilities Co., Atlantic Gas Corporation and Pennsylvania & Southern Gas Co. He was a member of the Board of Directors of the American Gas Association, and the National Trade Association of the Gas Utility Industry. Mr. Gellert perfected the Cottrell Process for electrostatic precipitation, so that it could be introduced into the steel industry for the cleaning of blast-furnace gases; the first big successful cleaning plant was designed by him and installed by the Colorado Fuel and Iron Co. of Pueblo Colo. He was known as the man who was instrumental in bringing natural gas to the Pacific Northwest. For many years he was connected with the Boy Scouts of America, serving as president of the Valley Forge Council, and member of the Executive Board of the Council. National Headquarters awarded him the insignia of the Silver Beaver for Distinguished Service to Boyhood. He was elected a member of the Board of Directors of the Seattle Gas Company. Mem. ASME, 1922. Member also, ASCE, American Gas Association ,Sigma Xi; recipient of John Addison Porter Prize, and Sanitary Engineers Prize.

Reginald Everett Gillmor (1887-1960), retired president of Sperry Gyroscope Co., and retired vice-president of the parent body, The Sperry Gyroscope Corp., died Feb. 7, 1960. Born Menominee, Wis., July 13, 1887. Parents, Daniel Webster and Jane (Shipman) Gillmor. Married Edwina Spear, 1915 (dec.). Married 2nd, Mrs. Marie Trudell Waynick, Aug. 22, 1947. Education, U. S. Naval Academy, 1907. He served in the navy from 1907 to 1912, and again during World War I, when he was flag secretary to the late Adm. William S. Sims. He joined the Sperry Gyroscope Co. in 1912 and established the Sperry Gyroscope Co., Ltd., in England. Mr. Gillmor was loaned to the State Department in 1947 as industry director of the American Mission to Greece. During his career in Sperry Gyroscope Co. he was Washington respresentative, sales manager, vice-president, and president; his influence was used in expanding the company into four separate divisions, and in devising a mobilization plan before the war. In 1948 he was appointed vice-chairman of the National Security Resources Board; later he was appointed on the Special Task Force Committee on the Maritime Commission and Chairman of Interagency Distressed Defense Areas Task Force. He was awarded the 1948 ASME Melville Medal for his paper "The World The Manager Lives In," judged the best paper presented before the society for the previous year. He is also recipient of the Scott Gold Medal "for distinguished service in the advancement of industrial preparedness." He had written and delivered many papers for the engineering, educational, and industrial fields. He served as trustee for Barnard College, Webb Institute of Naval Architecture, Hampton Institute, and Adelphi; and on the Board of Governors of the Aeronautical Chamber of Commerce of America, National Industrial Conference Board, National Association of Manufacturers, American Ordnance Association, Brooklyn Chamber of Commerce, and Scientific Apparatus Makers of America. Mem. ASME, 1940; Fellow ASME, 1956. Surviving are his wife; two sons, William S. and David S. Gillmor; two brothers, and a sister.

William Beans Goentner (1880-1959), self-employed mechanical engineer, Abington, Pa., died Dec. 25, 1959. Born, Willow Grove, Pa., Oct. 11, 1880. Parents, John Beans and Loretta (Neveil) Goentner. Education, BS(ME) Univ. of Pennsylvania, 1901. Married Edna C. Nagle, Oct. 6, 1903; daughter Helen. Mr. Goentner had wide experience in numerous lines of engineering, and chemical and metallurgical processes. As assistant engineer of the N.Y.C. Department of Water Supply, Gas & Electricity, he was in charge of the designs for remodeling the existing water-distribution systems of all five boroughs; he was hydraulic engineer for the National Board of Fire Underwriters, N. Y.; and plant superintendent for McCabe Chemical Co., Charlotte, N. C., responsible for construction, rehabilitation, and operation of the sulfuric acid chamber and concentrating plants. Mr. Goentner was also with Ampco Metal, Inc., Milwaukee, Wis.; The Superheater Co., East Chicago, Ind.; and The Beryllium Corp. of Pennsylvania; Jun. Mem. ASME, 1905; Mem. ASME, 1914. Member also, Sigma Xi.

Harold Edgar Haber, Jr. (1911-1959), industrial engineer for International Swimming Pool Corporation, died in New York City, Feb. 26, 1959. Born, New York, N. Y., May 13, 1911. Parents, Harold E. and Tessie (Kessel) Haber. Education, ME, Stevens Inst. of Tech., 1931; MS, 1937. Married Marjorie G. Maas, 1937. Assoc. Mem. ASME, 1932; Mem. ASME, 1942. He is survived by his wife and two children Marion M. and Nancy C. Haber of New York City. He had been with E. I. du Pont de Nemours & Co., Inc., and was assistant to the president and controller of Broadway Maintenance Corp., Long Island City, N. Y., previously.

Herbert Zucker Hale (1883-1960?), formerly with the Astra Bentwood Furniture Co., New York, N. Y., died recently according to report received by the Society. Born, Strakaniee, Czechoslovakia, June 15, 1883. Education, ME, Polytechnikum Zurich, Technische Hockschule, Vienna, 1906. He was with various firms in Austria, England, and Czechoslovakia before coming to the U. S. Here, after 1939, he was vice-president of Hale Co., Arlington, Vt., and president of the French-American Trading Co., Inc., New York, N. Y. Mem. ASME, 1943. He was a member of the Ingenieur & Architeketen Verein, Vienna, Austria, and a member of the French-American Chamber of Commerce, N.Y.C.

Wesley Harold Hall (1927-1959), design engineer, Engineering Div. Wilmot Castle Co., Rochester, N. Y., died Dec. 26, 1959. Born, Buffalo, N. Y., June 21, 1927. Parents, Wesley L. and Margaret L. Hall. Education, BS(ME), Univ. of Rochester, 1949. Mr. Hall had been with the U. S. Corps of Engineers and Taylor Instrument Companies. Mem. ASME, 1949. His wife, Mrs. Ann P. Hall, survives him.

Arthur Clifford Hartley (1889-1960), consultant and oil engineer, Rendel, Palmer, & Tritton, London, England, died Jan. 28, 1960. Born, Jan. 7, 1889, Hull, England. Education, Hull Technical Institute, 1908; Central Technical College, 1910; BS(Engrg.) Imperial College of Science & Technology, London; A.C.G.I., F.C.G.I. Mr. Hartley helped develop PLUTO (Pipeline Under the Ocean), the undersea pipeline that carried 172 million gallons of gasoline to Allied invasion forces in France between D-Day and the end of the war in Europe, and FIDO (Fog Investigation Dispersal Operations), the system that dispersed fog over bomber airfields. As a major in the Royal Flying Corps, he helped develop a synchronizing gear that enabled machine guns to fire between blades of aircraft propellers that revolutionized fighter aircraft tactics in World War I. In civil life he was best known as an oil designer. In 1924 he became assistant manager of the Anglo-Iranian Oil Co., Ltd., president of the Institution of Mechanical Engineers in 1951, and president of the Institution of Civil Engineers last year. He received the award of Commander of the British Empire in 1944 and the United States Medal of Freedom for his work in connection with FIDO. Mem. ASME, 1945. Fellow and vice-president, Institute of Petroleum.

George A. Hoffman (1876-1960?), retired, died recently according to notice received by the Society. Born, St. Louis, Mo., Dec. 17, 1876. Formerly with St. Louis Water Department as

supervisor of pumping stations. Mem. ASME, 1930.

Ray Herbert Holloway (1921-1960), plant engineer, Bemis Brothers Bag Co., Memphis, Tenn., died Jan. 6, 1960. Born, Sept. 27, 1921, Memphis, Tenn. Education, BS(ME), M.I.T., 1950. Assoc. Mem. ASME, 1950. He is survived by his wife, Mrs. Marie H. Holloway.

Bassett Jones (1877-1960), retired, died Jan. 23, 1960. Born, Staten Island, N. Y., Feb. 6, 1877. Education, attended M.I.T. Parents, Bassett and Sarah Catherine (Oakey) Jones. Married Emily Louise Warren, 1922. Mr. Jones developed lighting systems and elevators for skyscrapers, including the Empire State Building. Although inactive in business since 1933, he remained a partner in Meyer, Strong and Jones, consulting engineers, and directed illumination for the 1939 World's Fair. As chairman of research committees for the Merchants' Association here and the American Standards Association in Washington, he succeeded in having New York City revise its building code to allow elevators to go faster than 700 ft a minute to accommodate for the Empire State's elevators' speed of 1200 ft a minute. In 1912 he designed, for Miss Maude Adams, the first floodlight units used in a theater. His firm did the street illumination for Syracuse, N. Y., and lighting systems for the U. S. Military Academy, the Riverside Church, and the Freer Museum and Corcoran Gallery in Washington. Mr. Jones helped install the first self-service elevator in the Irving Trust Company building. With Charles Birdseye, he formed General Seafood Corporation in 1923 and became president, due to his development of a quick-freezing process for fish. Mr. Jones was the author, in 1933, of "Debt and Production, the Operating Characteristics of Our National Economy" and "Horses and Apples" (1934). At one time he was sent to Panama by the Federal Government to make studies of metallic corrosion and rust prevention for the Panama Canal. Mem. ASME, 1942. Member, also, AIEE, IES, American Statistical Society, and Society of American Foresters. Life member of American Forestry Association, National Horticultural Society, and American Geographical Society. He leaves his wife; two daughters, Miss Gwenyth Starr Jones and Mrs. William Hoiness, of his first marriage to the former Emma Starr, who died in 1920; and two grandsons.

Richard Eugene Kaiser (1927-1959), engineering specialist, Dodge Manufacturing Co., Mishawaka, Ind., died Dec. 8, 1959. Born, South Bend, Ind., April 17, 1927. Education, BS(ME), Purdue Univ., 1955. Mr. Kaiser had been associated with Bastian Morley Manufacturing Corp., LaPorte, Ind., and Bendix Aviation Corporation, South Bend, Ind., previously. Assoc. Mem. ASME, 1955.

Alexander Emanuel Kramer (1897-1960?), ordnance engineer, U. S. Department of Army, died recently according to report received by the Society. Born, Tsingtau, China, Sept. 22, 1907. Education, BS(ME), Heald Engineering College, 1932; attended George Washington Univ. and Univ. of Maryland. As mechanical engineer for Owens Illinois Pacific Coast Co., San Francisco, Calif., he was engaged in development of mold equipment and automatic machinery for production of glass containers. With the department of the Army he was assistant chief of automatic weapons and carriage section, and administer of research and development program on automatic weapons and feeder mechanisms for use in aircraft and antiaircraft installations. Mr. Kramer was ordered to the European theater on a mission to evaluate projects under development during World War II; on completion of the mission he submitted a treatise on Ordnance Materiel in Germany which earned acclaim. His patents include those on recoil mechanisms, a hydraulic muzzle cover, an automatic weapon, and multichambered pressure cooker. In 1955 he was awarded by the Department of the Army a citation "for meritorious performance of duty as a general ordnance design engineer. . .his proficiency in developing the basic design for an antiaircraft weapon of unprecedented high rate of fire contributed to a significant technical achievement. . ." Mem. ASME, 1955.

Charles Junior Lahman (1912-1958), owner, Charles J. Lahman & Associates, died Oct., 1958, according to a notice recently received by the Society. Born, Dayton, Ohio, Feb. 18, 1912. Education, The Hays Institute, 1939. For several years Mr. Lahman was with W. I. Barrows & Associates, Dayton, Ohio, consulting engineers, specializing in power and heating plants. He was awarded the "Certificate of Competency" by the National Association of Power Engineers of which he was a member. Mem. ASME, 1951.

Henry Mah (1929-1959), combustion engineer, Gypsum Lime & Alabastine, Ltd., died in a car accident at Brantford, Ont., Canada, Dec. 28, 1959. Born, Nanaimo, B. C., Can., Nov. 29, 1929. Education, BS(ME), Univ. of Toronto. Assoc. Mem. ASME, 1957.

Stephen Winfred Molokie (1894-1950), architect superintendent for Bartlett Cooke Architects, San Antonio, Texas, died Dec. 24, 1959. Born, New Brighton, N. Y., Aug. 18, 1894. Parents, James and Catherine Molokie. Education, Copper Union, 1917; extension courses at Penn State College and Pratt Institute. Married Charlotte Ward Mullin, 1924. Jun. Mem. ASME, 1917; Assoc-Mem. ASME, 1925; Mem. ASME, 1935. From 1928 to 1935 he was with the United Engineers & Constructors, Philadelphia, Pa.; with Schultze & Weaver, New York; Voorhees, Gmelin & Walker during the construction of the Irving Trust Building in New York City; with Jas. Stewart & Co. during construction of the Cities Service Building, New York; with Marc Eidlitz & Son during construction and alteration of the Frick Collection Buildings, New York; and with the New York firm of Cross & Brown. On one assignment for the City of New York he was in charge of maintaining electrical and mechanical equipment of a high-tension 125 million daily capacity sewage-treatment plant. He was a member of the Society of American Military Engineers and the Registered Professional Engineers in the states of New York and Texas. He had many civic interests. He served as chairman of Shavano Park (Section of San Antonio) Planning Board as well as director of SP Voluntary Fire Department. Survivors are his wife, a sister, a brother, and numerous nieces and nephews.

Edwin Carl Nelson (1911-1959), assistant head of industrial planning, Bureau of Ordnance, Department of the Navy, died in Aug., 1959, according to a report recently sent to the Society. Born, Washington, D. C., Oct. 20, 1911. Parents, Axel A. and Anna M. Nelson. Education, attended Emerson Inst., 1933; George Washington Univ., 1937; Columbia Technical, 1941. Married Dorothy Dessez, 1936. Mr. Nelson received the Meritorious Civilian Award from the Navy in 1947 and three other monetary awards for his services. A registered engineer in Washington, D. C., he served with the Bureau of Ordnance, U. S. Navy Department since 1942. Mem. ASME, 1956.

Lowell Marvin Newman (1903-1959), plant engineer, Crystal Tissue Co., Middletown, Ohio, died Sept. 14, 1959. Born, Bradford, Ohio, Sept. 28, 1903. Education, Antioch College, 1929-1935. He was power-plant operating engineer at Antioch College and assisted the dean of engineering in power-plant studies. With Crystal Tissue Co. since 1936, he had charge of the selection, design, and installation of power-plant equipment, large piping systems, and fire-protection equipment systems. He was a registered engineer in the State of Ohio. Mem. ASME, 1950. Member, also, Ohio Section of TAPPI, the American Pulp & Paper Mill Superintendents Association. He served his community as chairman of the Monroe Planning and zoning committee and as engineer of the Monroe Board of Public Affairs. He is survived by his wife, Hilda, and two daughters.

Bartholomew Edward Pinter (1909-1959), checker, A.C. Spark Plug Div., General Motors Corp., Milwaukee, Wis., died in December, 1959. Born, Milwaukee, Wis., May 4, 1909. Parents, Barth and Theresa (Rogar) Pinter. Education, BME, Marquette College of Engineering, 1933. Married Antoinette Wagner; three children, Robert, Marilyn, and Martin. Mr. Pinter had been associated with Kearney & Trecker Corp., Harnischfeger Corp., and Automatic Products Co., Milwaukee. Mem. ASME, 1946. In 1951–1952 season he served as assistant program chairman of his Section. Registered PE in the State of Wisconsin.

Jaroslav Joseph Polivka (1886-1960), consulting structural engineer and educator of Berkeley, Calif., died on Feb. 9, 1960. Born, Prague, Czechoslovakia, April 20, 1886. Parents, Joseph and Francisca (Urbanova) Polivka. Education, master's degree, Technical Univ. of Prague, 1909; Dr. Tech. Sci., 1917; graduate study at the Federal Inst. of Tech., Zurich, Switzerland, 1911. Married Marie I. Polakova, 1913. He designed and supervised the construction of many notable structures in Europe including buildings, dams, and bridges; and became recognized as an authority on mathematical and experimental stress analysis, particularly photoelasticity. Some of his work was in association with such outstanding authorities as Emperger and Mesnager. He designed the Czech pavilion at the Paris International Exhibit in 1937. The following year he came to the United States to supervise construction of the Czech pavilion, which he designed, for the New York World's Fair, 1939–1940; he then settled in California and, in 1945, became a naturalized U. S. citizen. He was a research associate at the Univ. of California, 1939–1945, and a lecturer at Stanford Univ. from 1951 until the time of his death. He continued his construction practice by designing unusual structures and consulting on special features of such structures as the Guggenheim Museum in New York City; the Johnson Wax Co. Research Tower, Racine, Wis.; Tioga Building, and the "butterfly bridge" which has been proposed for crossing the southern arm of San Francisco Bay. In much of his practice he was associated with the world famous architect, Frank Lloyd Wright. Mem. ASME, 1944. He was the winner of a number of competitions and awards. These include the international competition for design of proposed tunnel, Belvedere, Prague, 1909; French Society of Civil Engineers Colombet award for best structural achievement in past four years, 1936; gold medal and two diplomas of honor, Paris International Exposition, 1937; Officer Legion of Honor French Etoile Noire de Benin, 1951. He held membership in many professional and technical societies both here and abroad; he was the author of several books and articles published in English and translated into many languages; and, with Victor di Suvero, he invented hyperbolic-paraboloid structures. He held many patents relating to special structures. Survived by wife; a daughter, Elizabeth Houdek of Berkeley; and two sons, Jan, a civil engineer, New York City, and Milos, associate professor of civil engineering, University of California, Berkeley.

William Allan Sloan (1890-1960), professor-emeritus of mechanical engineering, University of Pennsylvania, died Jan. 31, 1960. Born, Philadelphia, Pa., Dec. 7, 1890. Education, BS(ME) Univ. of Pennsylvania, 1912. He taught at the University of Pennsylvania without interruption until his retirement in 1956. He was an authority on internal-combustion engines and power. A former president of the University's Engineering Alumni Society, Professor Sloan was a member of The Franklin Institute and Engineers Club of Philadelphia. Assoc. Mem. ASME, 1921; Mem. ASME, 1930. Surviving are his wife, the former Carrie McGowan; a son, Robert; and one sister.

Edric Brooks Smith (1887-1960?), retired, died recently according to report received by the Society. Born, June 9, 1887, Cambridge, Mass. Education, SB, Lawrence Scientific School, 1908; attended Graduate School of Applied Science, Harvard University. In 1913 he was employed by the Rockefeller Institute for Medical Research as junior assistant manager and progressing to the position of business manager and secretary. Assoc. Mem. ASME, 1913; Mem. ASME, 1935. His wife, Laura Seaver Smith, died in 1944. They had four children.

Herbert Lincoln Spencer (1894-1960), executive director of the Samuel H. Kress Foundation, died Jan. 29, 1960. Born, Whitney Point, N. Y., July 13, 1894. Education, BS(ME), Carnegie Inst. of Tech., 1921; MA, Univ. of Pittsburgh, 1927; PhD, Univ. of Pittsburgh, 1934. His engineering career included service with American Telephone and Telegraph Co., Westinghouse Airbrake Corp., Jones and Laughlin Steel Corp., and Carnegie Steel Corp. Dr. Spencer taught junior high school, became principal of Henry Clay Frick Training School for Teachers in 1928, and in 1934 was made dean of the liberal arts college of the Univ. of Pittsburgh. The following year he was chosen president of the Pennsylvania College for Women in Pittsburgh. He became president of Bucknell University in 1945. He resigned in 1949 to take the newly created post of executive director of the Samuel H. Kress Foundation, a philanthropy devoted mainly to the fields of postgraduate medicine and art. He was a director of the New York Univ. Bellevue Medical Center and a member of the board of directors of the Chemicon Corp. of New York. He is survived by his widow, Mildred, and two daughters, Mrs. L. D. Schaller, Ligonier, Pa., and Miss Sally Louise Spencer, New Haven. Mem. ASME, 1947.

Ray Nathaniel Wheelock (1897-1960), director of the Engineering Department, Hercules Powder Co., Wilmington, Del., died Jan. 13, 1960. Born, Portland, Maine, Sept. 23, 1897. Education, BS(ME), M.I.T., 1925. He became associated with Hercules Powder plant in 1925 and remained with the company until his death. One special assignment took him to France in 1938–1939 to study ammonia processes before designing the ammonia plant which was to be erected later at Hercules, Calif. He was appointed assistant chief engineer of the Wilmington plant in 1945, and, in 1947, was appointed chief engineer. Mem. ASME, 1947. Survivors include his widow, the former Marion Smiley; a daughter, Mary Elizabeth; and two sisters.

Frederick William Winyard (1915-1959), production manager, New Construction Div., National Steel & Shipbuilding Corp., San Diego, Calif., died in October, 1959, according to a notice recently sent to the Society. Born, Hong Kong, China, Dec. 11, 1915. Education, Technological Institute of Great Britain, 1938. Citizen of U. K. and colonies. Mr. Winyard's specialty was ship design, machinery design, diesel engines, and ship salvaging. He had been with the Brooke Dockyard and Engineering Works, Kuching, Sarawak, Borneo in charge of the dockyard. During the war, as member of the Royal Engineers, British Armed Forces, he built and engineered craft for special operations. He is author of the publication, "Salvaging of Vessels in Inland Waters Under Primitive Conditions." Assoc. Mem. ASME, 1955. Member, also, Society of Naval Architects and Marine Engineers, North East Coast Institution of Engineers and Shipbuilders, SAE, Institute of Naval Architects, and Institute of Locomotive Engineers. Survived by wife, Florence Winyard.

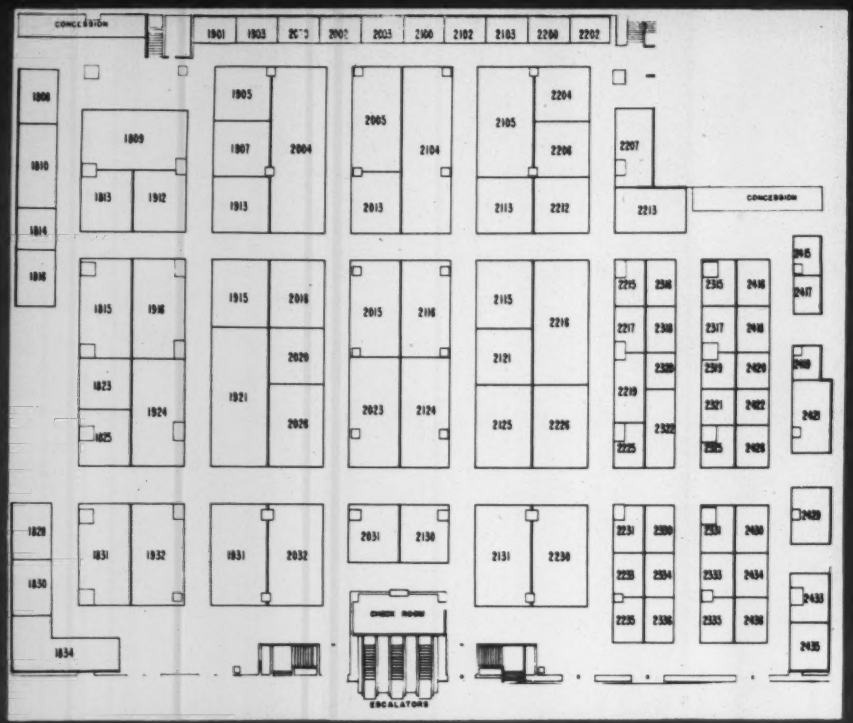
1960
DESIGN ENGINEERING CONFERENCE

and concurrent **DESIGN ENGINEERING SHOW**

1 EXHIBIT FLOOR PLANS
2 LIST OF EXHIBITORS
3 CONFERENCE PROGRAM
4 CONFERENCE PAPER DIGESTS

NEW YORK COLISEUM
MAY 23-26, 1960

FIRST FLOOR



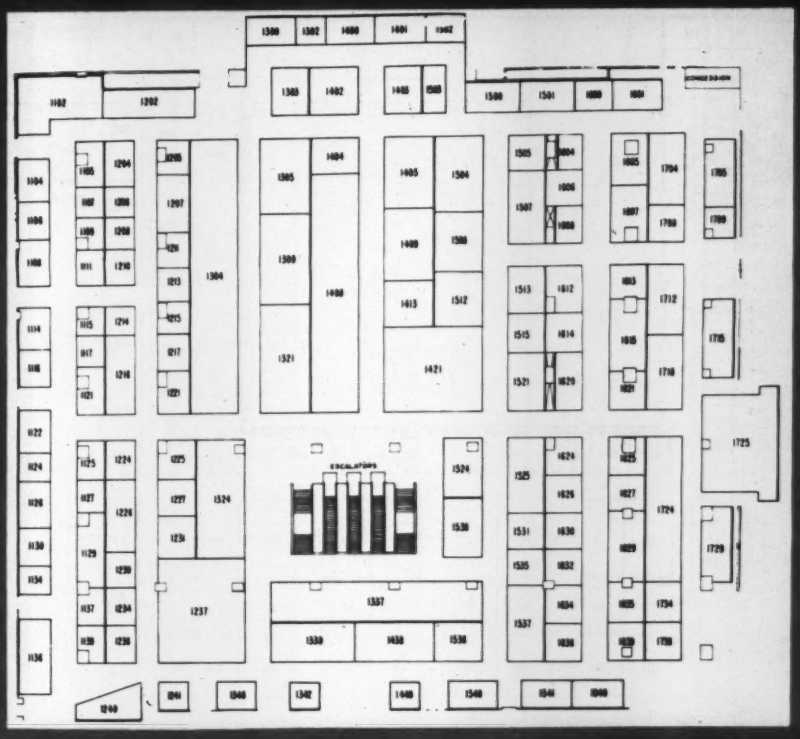
list of exhibitors

MECHANICAL COMPONENTS

	Booth No.
A.P.M. Corp.	915
Aetna Ball & Roller Bearing Co.	927
Air-Maze Corp.	1134
Alemite Division, Stewart-Warner Corp.	732
Aluminum Company of America	2032
Amco Engineering Corp.	337
American Laubscher Corp.	1130
Amplex Division, Chrysler Corp.	1125
Arch Instrument Co.	222
Arguto Oilless Bearing Co.	525
Artus Corp.	317
Arwood Corp.	117
Associated Spring Corp.	1924
Atlas Chain & Mfg. Co.	1916
Atlas Precision Products Co.	1916
The Auburn Manufacturing Co.	1505
Barry Controls Inc.	1624
Beaver Precision Products, Inc.	236
Beemer Engineering Co.	1127
Binks Manufacturing Co.	829
Boston Gear Works	1808
Brass & Bronze Ingot Institute	338
Bridgeport Thermostat Division, Robertshaw-Fulton Controls Co.	425
Carr Fastener Company Division, United-Carr Fastener Corp.	530
Chain Belt Co.	526
Chicago-Allis Manufacturing Corp.	2318
The Cleveland Graphite Bronze Division of Clevite Corp.	2204
Commercial Filters Corp.	504
Corbin Cabinet Lock Division, American Hardware Corp.	214
Corbin Hose Clamp Division, American Hardware Corp.	214
Cramer Controls Corp.	2333
Crane Packing Co.	512
Dayton Industrial Products Co., Division of Dayton Rubber Co.	1607
Disogrin Industries	219
Dixon Sintaloy Inc.	2102
Doehler-Jarvis Division, National Lead Co.	2026
Duff-Norton Co.	516
Durametallic Corp.	1012
Dynamic Gear Co., Inc.	1104
Dzus Fastener Co., Inc.	735
Eaton Manufacturing Co.	1337
Engineered Plastics Inc., American Sinterings Division	1535
Eriez Manufacturing Co.	1114
Falstrom Co.	1818
Faultless Caster Corp.	2202
Fawick Airflex Division, Fawick Corp.	1136
Flexonics Corp.	2421
Garlock Packing Co.	2206
Grand Sliding Mechanism Inc.	312
Gries Reproducer Corp.	2435
Hartford Steel Ball Co., Inc.	1026
The Heim Co.	2113
Heyman Manufacturing Co.	1217
Hoover Ball and Bearing Co.	426
Hunter Spring Co.	1512
Illinois Tool Works	1629
Industrial Tectonics, Inc.	1404
International Packings Corp.	1309
The Kaydon Engineering Corp.	2429
Kennametal Inc.	1305
Landis and Gyr, Inc.	1830
Lee Spring Co., Div. of Leetronics, Inc.	1109
Lignum Vitae Products Corp.	2417
Link-Belt Co.	2105
Lord Manufacturing Co.	1620
MM Enclosures, Inc., Affiliated with A & P Metal Products Mfg. Corp.	2335
McGill Manufacturing Co., Inc.	1907
Metal Powder Industries Federation	1525
Micro Switch Division, Minneapolis-Honeywell Regulator Co.	1202
Mobay Chemical Co.	1129
Mueller Brass Co.	1405
National Tube Division, United States Steel Corp.	2104
New Departure Division, General Motors Corp.	633
Nice Ball Bearing Co.	2321
Ohio Seamless Tube Division, Copperweld Steel Co.	629
Orange Roller Bearing Co., Inc.	1636
Park Nameplate Co., Inc.	911
Pic Design Corp., Subsidiary of Benrus Watch Co.	1208
The Polymer Corp.	1513
Precision Specialties, Inc.	301
Pressco Casting and Mfg. Corp.	1302
Ramsey Corp.	2436
Randall Graphite Bearings, Inc.	914
Raybestos-Manhattan, Inc.	1810
Roller Bearing Co. of America	1530
Rollway Bearing Co., Inc.	419
SKF Industries, Inc.	1932
Screen Products Co.	913
Scully-Jones & Co.	122
Sealol Corp.	1340
Sier-Bath Gear and Pump Co., Inc.	2031
Sigmamotor Inc.	2315
Simmons Fastener Corp.	2434
Spiroid Division, Illinois Tool Works	1629
Sterling Precision Corp.	2319
Stokes Molded Products Division, Electric Storage Battery Co.	920
Stow Manufacturing Co.	1011
Superite Instrument Corp.	414
Syntran Co.	2105
Thomson Industries, Inc.	2115
United Shoe Machinery Corp.	924
U. S. Electrical Motors Inc.	1704
Vanton Pump & Equipment Corp., Division of Cooper Alloy Corp.	226
Veeder-Root Inc.	2316
Vibro-Plus Products, Inc.	2325
Warner Automotive Division, Borg-Warner Corp.	2213
Web Controls Corp.	1729
The Zero-Max Co., Subsidiary of Revco Inc.	1640

POWER TRANSMISSION EQUIPMENT

	Booth No.
AMP Inc.	1303
Acme Chain Corp.	413
Aluminum Company of America	2032
Anaconda Metal Hose Division, American Brass Co.	1236
Arguto Oilless Bearing Co.	525
Artus Corp.	317
Beaver Precision Products, Inc.	236
Boston Gear Works	1808
Brammer Corp.	1440
Bridgeport Thermostat Division, Robertshaw-Fulton Controls Co.	425
Browning Manufacturing Co.	2207
Chain Belt Co.	526
Chicago-Allis Manufacturing Corp.	2318
The Cleveland Graphite Bronze Division of Clevite Corp.	2204
Cleveland Worm & Gear Division, Eaton Manufacturing Co.	1337
Congress Drives Division, Tann Corp.	1018
Cullman Wheel Co.	2225
Dayton Industrial Products Co., Division of Dayton Rubber Co.	1607
De Laval Steam Turbine Co.	833
Diamond Chain Co., Inc.	424
Dodge Manufacturing Corp.	1834
Duff-Norton Co.	516
Eaton Manufacturing Co.	1337
Eclipse Machine Division, Bendix Aviation Corp.	125
Engineered Plastics Inc., American Sinterings Division	1535
Fawick Airflex Division, Fawick Corp.	1136
Flexonics Corp.	2421
Foote Bros. Gear and Machine Corp.	828
Graham Transmission Inc.	835
The Heim Co.	2113
The Hilliard Corp.	1905
Janette Electric Mfg. Co.	626
The Kaydon Engineering Corp.	2429
Link-Belt Co.	2105
Lovejoy Flexible Coupling Co.	1504
Maurey Manufacturing Corp.	2317
McGill Manufacturing Co., Inc.	1907
Mobay Chemical Co.	1129
Morse Chain Co., A Borg-Warner Industry	1931
National Tube Division, United States Steel Corp.	2104
New Departure Division, General Motors Corp.	633
Patron Transmission Co., Inc.	1440
Poole Foundry & Machine Co.	428
Precision Specialties, Inc.	301
Pressco Casting and Mfg. Corp.	1302
Randall Graphite Bearings, Inc.	914
Raybestos-Manhattan, Inc.	1810
Reliance Electric & Engineering Co.	2023
Rockwood Pulley Mfg. Co., Inc.	1440
Rollway Bearing Co., Inc.	419
Saginaw Steering Gear Division, General Motors Corp.	1508
A Schrader's Son, Division of Scovill Mfg. Co.	1831
Sealol Corp.	1340
Sier-Bath Gear and Pump Co., Inc.	2031
Sigmamotor Inc.	2315
Simplatrol Products Corp.	2415
The Snow Nabstedt Gear Corp.	1709
Sterling Precision Corp.	2319
Stow Manufacturing Co.	1011
Tann Corp., Congress Drives Division	1018
Thomas Flexible Coupling Co.	1600
United Shoe Machinery Corp.	924
U. S. Electrical Motors Inc.	1704
United States Rubber Co., Mechanical Goods Division	1324
John Waldron Corp.	2200
Warner Electric Brake & Clutch Co.	1004
Web Controls Corp.	1729



SECOND FLOOR

list of exhibitors

	Booth No.
Winsmith Inc.	528
T. B. Wood's Sons Co.	1736
Worthington Corp.	316
Zero-Max Co., Subsidiary of Revco Inc.	1640

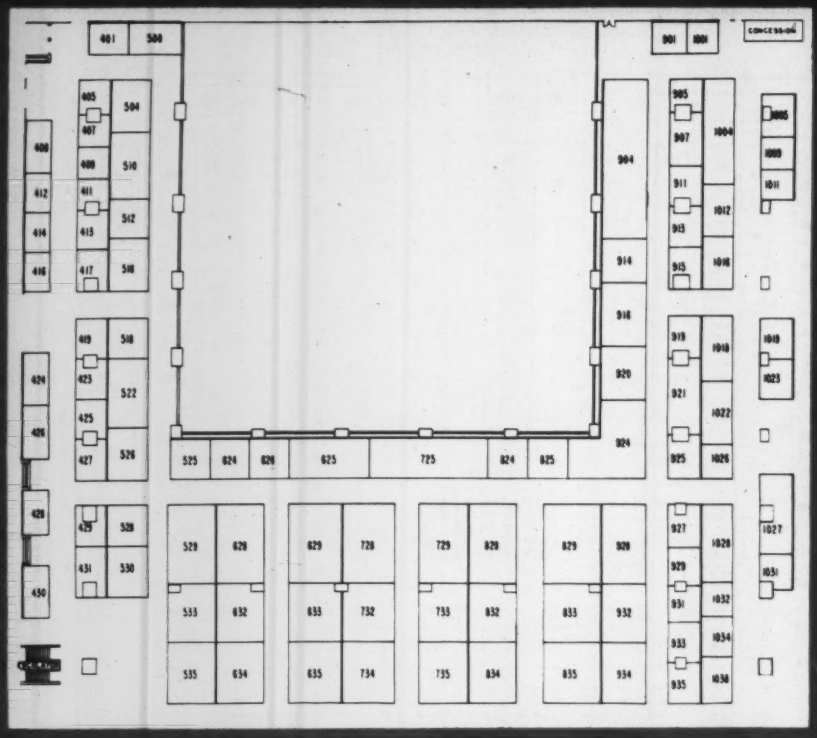
ELECTRICAL AND ELECTRONIC COMPONENTS

	Booth No.
ACF Electronics Div., ACF Industries, Inc.	126
A'G'A' Division, Elastic Stop Nut Corp. of America	2216
AMP Inc.	1303
A.P.M. Corp.	915
Acro Division, Robertshaw-Fulton Controls Co.	427
Adams & Westlake Co.	1038
Louis Allis Co.	1712
Aluminum Company of America	2032
Anaconda Metal Hose Division, American Brass Co.	1236
Artus Corp.	317
The Auburn Manufacturing Co.	1505
Automatic Switch Co.	1438
Beemer Engineering Co.	1127
Bendix Computer Division, Bendix Aviation Corp.	121
W. H. Brady Co.	1734
Bristol Co.	430
Brook Motor Corp.	1614
Brush Beryllium Co.	733
Buchanan Electrical Products Corp.	2216
Burling Instrument Co., Inc.	2100
Carr Fastener Co. Division, United-Carr Fastener Corp.	530
Century Electric Co.	1537
Cherry Electrical Products Corp.	1613
Circle F Mfg. Co.	423
Cleveland Graphite Bronze Division of Clevite Corp.	2204
Columbus Electric Manufacturing Co.	429
Control Devices, Minneapolis-Honeywell Regulator Co.	1202
Coors Porcelain Co.	1108
Corbin Cabinet Lock Division, American Hardware Corp.	214
Crane Packing Co.	512
Dearborn Glass Co.	431
Deluxe Coils, Inc.	322
Detroit Controls Division of American Radiator & Standard Sanitary Corp.	1230
Dixon Sintaloy Inc.	2102
Dobeckmun Co., A Div. of Dow Chemical Co.	2121
Doehler-Jarvis Division, National Lead Co.	2026
E. I. du Pont de Nemours & Co., Inc., Film Department	1413
Durakool, Inc.	1708
Eaton Manufacturing Co.	1337
Ebert Electronics Corp.	2217
Engineered Plastics Inc., American Sinterings Division	1535
Fawick Airflex Division, Fawick Corp.	1136
Fenwal Inc.	1621
Franklin Electric Co., Inc.	1705
Garlock Packing Co.	2206
General Electric Co.	1724
General Controls Co.	1608
Gries Reproducer Corp.	2435
Heyman Manufacturing Co.	1217
Illinois Tool Works	1629
Instrument Specialties Co., Inc.	2426
Janette Electric Mfg. Co.	626
Landis and Gyr, Inc.	1830
Lead Industries Association	632
Lear, Inc., Instrument Division	339
Lee Spring Co., Div. of Leetronics, Inc.	1109
Licon Division, Illinois Tool Works	1629
Linemaster Switch Corp.	1224
Martin Engineering Co.	1903
Micro Switch Division, Minneapolis-Honeywell Regulator Co.	1202
Miller Electric Co.	1541
Mobay Chemical Co.	1129
Mueller Brass Co.	1405
Mycalex Corporation of America	1400
National Beryllia Corp.	308
National Tube Division, United States Steel Corp.	2104
New Departure Division, General Motors Corp.	633
Nicad Sealed Cell, Div. of Gould-National Batteries, Inc.	311
Panduit Corp.	409
Permacel	933
Pic Design Corp., Subsidiary of Benrus Watch Co.	1208
Polymer Corp.	1513
Potter & Brumfield, Division of American Machine and Foundry Co.	1503
Pressco Casting and Mfg. Corp.	1302
Ramsey Corp.	2436
Randall Graphite Bearings, Inc.	914
Reliance Electric & Engineering Co.	2023
Reynolds Metal Co.	1921
M. H. Rhodes, Inc.	2231
Sanders Associates, Inc.	2215
Simplatrol Products Corp.	2415
Sola Electric Co., A Div. of Basic Products Corp.	905
Space Components Inc.	340
Stahlin Bros., Inc.	2003
Sterling Precision Corp.	2319
Stokes Molded Products Division of Electric Storage Battery Co.	920
Sylvania Electric Products Inc.	1521
Syntron Co.	2105
Thomas & Betts Co., Inc.	1108
Titeflex Inc.	408
United Shoe Machinery Corp.	924
U. S. Electrical Motors Inc.	1704
Veeder-Root Inc.	2316
Vibro-Plus Products, Inc.	2325
Warner Electric Brake & Clutch Co.	1004
Web Controls Corp.	1729
Weckesser Co.	1124
Edwin L. Wiegand Co.	2336
Westinghouse Electric Corp.	325
Westline Products Division of Western Lithograph Co.	2320
Zenith Electric Co.	1241
The Zero-Max Co., Subsidiary of Revco Inc.	1640

METALS

	Booth No.
Acme Steel Co.	2235
Aluminum Company of America	2032
American Nickeloid Co.	2418
American Smelting and Refining Co.	904
Ampco Metal, Inc.	1612
Armco Steel Corp.	725
Arvin Industries, Inc., Arvinyl Div.	2219
Bendix Computer Division, Bendix Aviation Corp.	121
Beryllium Corp.	342
Brass & Bronze Ingot Institute	338
Brush Beryllium Co.	733
Cerro de Pasco Sales Corp.	1204
Clad-Rex Division of Simoniz Co.	932
Cleveland Graphite Bronze Division of Clevite Corp.	2204
Climax Molybdenum Co., Division of American Metal Climax Inc.	1825
Cobalt Information Center, c/o Battelle Memorial Institute	2331
Cooper Alloy Corp.	300
Copper & Brass Research Association	529
Curtiss-Wright Corp., Marquette Metal Division	329
Dearborn Glass Co.	431
Doehler-Jarvis Division, National Lead Co.	2026
Drop Forging Association	832
Eaton Manufacturing Co.	1337
Engineered Precision Casting Co.	909
Flexonics Corp.	2421
Handy & Harman	1715
Haynes Stellite Co., Division of Union Carbide Corp.	1408
International Nickel Co., Inc.	1815
Janney Cylinder Co.	500
Jones & Laughlin Steel Corp., Stainless & Strip Division	519
Johnson Bronze Co.	1531
Kaiser Aluminum & Chemical Sales, Inc.	2005
Kennametal Inc.	1305
Laminated Shim Co., Inc.	1221
LaSalle Steel Co.	1321
Lead Industries Association	632
Malayan Tin Bureau	2430
Master Etching Corp.	417
Matthiessen & Hegeler Zinc Co.	314
Meehanite Metal Corp.	2228
Metal Powder Industries Federation	1525
Mueller Brass Co.	1405
New Departure Division, General Motors Corp.	633
Newark Wire Cloth Co.	2233
Ohio Knife Co.	829
Ohio Seamless Tube Division of Copperweld Steel Co.	629
Olin Mathieson Chemical Corp. Aluminum Division	729
O'Neil-Irwin Manufacturing Co.	1402
Penn Metal Co., Inc.	2418
Poloron Products, Inc.	518
H. K. Porter Co., Inc., Riverside-Alloy Metal Divison	142
Pressco Casting and Mfg. Corp.	1302
Randall Graphite Bearings, Inc.	914
Republic Steel Corp.	2131
Revere Copper and Brass Inc.	1102
Reynolds Metal Co.	1921
Rigidized Metals Corp.	1122
Superior Tube Co.	2020
Arthur Tickle Engineering Works, Inc.	1901

THIRD FLOOR



list of exhibitors

	Booth No.
Union Carbide Corp.	1408
Union Carbide Metals Co., Division of Union Carbide Corp.	1408
United States Steel Corp.	2104
Universal Castings Corp.	1632
Waukesha Foundry Co.	834
Wolverine Tube, Division of Calumet & Hecla, Inc.	221

NONMETALLIC MATERIALS

American Smelting and Refining Co.	904
Anchor Plastics Co.	2103
Auburn Manufacturing Co.	1505
Avery Label Co., A Division of Avery Adhesive Products, Inc.	535
Celanese Plastics Co., Division of Celanese Corporation of America	1237
Chemo Products, Inc.	124
Chicago-Allis Manufacturing Corp.	2318
Colonial Rubber Co.	934
Columbus Coated Fabrics Corp.	533
Conneaut Rubber & Plastics Co.	934
Continental-Diamond Fibre Co.	1540
Coors Porcelain Co.	1108
Corning Glass Works	1507
Crane Packing Co.	512
Disogrin Industries	219
Dixon Corp.	1206
Dobeckmun Co., A Div. of The Dow Chemical Co.	2121
Dow Corning Corp.	1915
E. I. du Pont de Nemours & Co., (Inc.), Elastomer Chemicals Department	1409
Orchem Dept., Freon Div.	1502
Polychemicals Department	1421
Eastman Chemical Products, Inc., Plastics Division	2004
Emjay Co., Inc.	522
Ethylene Corp.	1028
Farley & Loetscher Mfg. Co., Plastics Division	405
Farval Division, Eaton Manufacturing Co.	1337
Fasson Products	218
Fiberfil Inc.	919
Garlock Packing	2206
E. D. Geoffrey Garth and Associates	1031
Glass Laboratories, Inc.	1107
Hungerford Plastics Corp.	1205
Lancaster Glass Corp.	1342
Lead Industries Association	632
Lehigh Chemical Co.	1500
Lignum Vitae Products Corp.	2417
Marbon Chemical Division, Borg-Warner Corp.	728
Masland Duraleather Co.	1912
Mechanical Rubber Products Co.	309
Mobay Chemical Co.	1129
Mycalex Corporation of America	1400
National Beryllia Corp.	308
National Vulcanized Fibre Co.	1913
New England Laminates Co., Inc.	1627
O'Sullivan Rubber Co.	2420
Pennsylvania Fluorocarbon Co., Inc.	1032
Parmacel	933
Polygon Plastic Co.	230
The Polymer Corp.	1513
Raybestos-Manhattan, Inc.	1810
Rohm & Haas Co.	2116
Spaulding Fibre Co.	1016
Spencer Chemical Co.	624
Stokes Molded Products Division of Electric Storage Battery Co.	920
Synthane Corp.	1126
Toyad Corp.	1515
Union Carbide Corp.	1408
Union Carbide Plastics Co., Division of Union Carbide Corp	1408
United States Plywood Corp.	1117
United States Rubber Co., Mechanical Goods Division	1324
United States Rubber Co., Royalite Division	1324
United States Steel Corp.	2104
U. S. Stoneware Co.	934
Westline Products Division of Western Lithograph Co.	2320

FASTENERS AND ADHESIVES

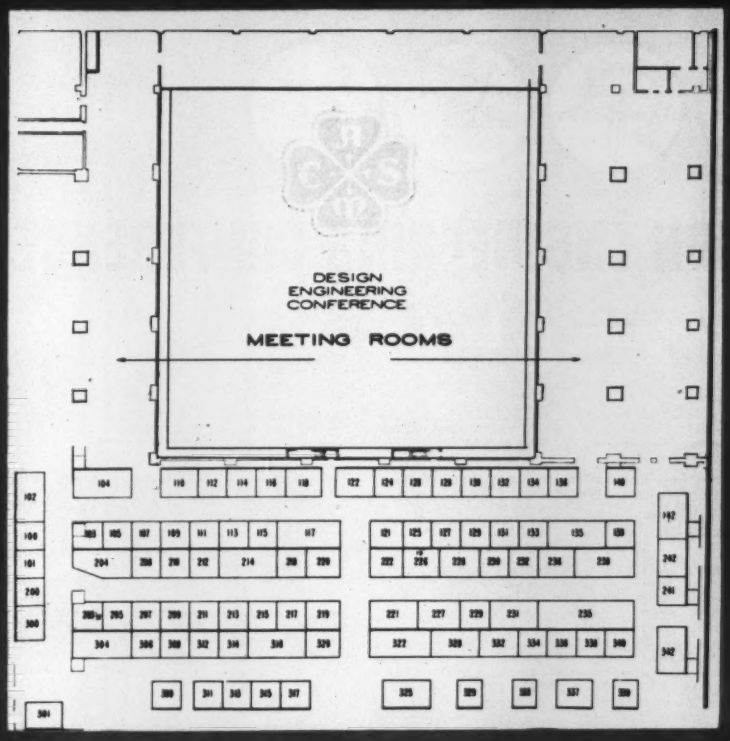
AMP Inc	1303
A.P.M. Corp.	915
Acme Steel Co.	2235
Aluminum Company of America	2032
American Sealants Co.	1009
Ampco Metal, Inc	1612
Auburn Manufacturing Co.	1505
Avery Label Co., Division of Avery Adhesive Products, Inc., Decorative Products Department	535
Bristol Co.	430
Camloc Fastener Corp.	1814
Carr Fastener Company Division, United-Carr Fastener Corp.	530
Corbin Cabinet Lock Division, American Hardware Corp.	214
Corbin Hose Clamp Division, American Hardware Corp.	214
Deutsch Fastener Corp.	315
Dzus Fastener Co., Inc.	735
Eastman Chemical Products, Inc , Chemicals Division	1626
Eaton Manufacturing Co.	1337
Elastic Stop Nut Corporation of America	2216
H. B. Fuller Co.	411
E. D. Geoffrey Garth and Associates	1031
B. F. Goodrich Aviation Products, Div of B. F. Goodrich Co.	1403
Gries Reproducer Corp.	2435
Groov-Pin Corp.	2330
John Hassall, Inc.	1639
Heli-Coil Corp.	1828
Illinois Tool Works	1629
Keystone Bolt and Nut Corp.	401
Lamson & Sessions Co.	2002
Lee Spring Co., Div. of Leetronics, Inc.	1109
Mac-It Parts Co.	1604
MacLean-Fogg Lock Nut Co.	1121
Minnesota Mining and Manufacturing Co.	1718
Mobay Chemical Co.	1129
Moeller Manufacturing Co.	313
Samuel Moore & Co.	104
Nylock Corp.	139
Painut Co.	306
Parker-Kalon Division of General American Transportation Corp.	635
Penn Engineering & Manufacturing Corporation	1023
Permacel	933
Ramsey Corp.	2436
Raybestos-Manhattan, Inc.	1810
Reed & Prince Manufacturing Co.	1501
Robin Products Co.	333
Rosan Inc.	1215
Shakeproof Division, Illinois Tool Works	1629
Simmons Fastener Corp.	2434
Southco Division, South Chester Corp.	1210
Standard Pressed Steel Co.	2124
Star Expansion Industries Corp.	1234
Judson L. Thomson Mfg. Co.	625
Tinnerman Products, Inc.	1226
Tubular Rivet & Stud Co.	238
United Shoe Machinery Corp.	924
Waldes Kohinoor, Inc., Truarc Retaining Rings Division	2016
Weckesser Co.	1124
Wittek Manufacturing Co.	2422

FINISHES AND COATINGS

Aluminum Company of America	2032
American Nickeloid Co.	2418
American Smelting and Refining Co.	904
Arvin Industries, Inc., Arvinyl Div.	2219
Avery Label Co., Division of Avery Adhesive Products, Inc., Decorative Products Department	535
Chromalloy Corp. of N. Y.	135
Clad-Rex Division of Simoniz Co.	932
Coating Products, Inc.	2013
Columbus Coated Fabrics Corp.	533
Dobeckmun Co., Div. of Dow Chemical Co.	2121
Doehler-Jarvis Division, National Lead Company	2026
Lead Industries Association	632
Marlane Development Co., Inc.	320
Masland Duraleather Co.	1912
Metal & Thermit Corp.	332
Mobay Chemical Co.	1129
Parmacel	933
Poloron Products, Inc.	518
Polymer Corp.	1513
Rigidized Metals Corp.	1122
Roehlen Engraving Works	1227
Sifco Metachemical Inc.	320
Arthur Tickle Engineering Works, Inc.	1901
United Shoe Machinery Corp.	924
U. S. Stoneware Co.	934

SHAPES AND FORMS

Alloy Products Corp.	1240
Aluminum Company of America	2032
American Smelting and Refining Co.	904
Ampco Metal, Inc.	1612
Anchor Plastics Co., Inc.	2103
Arvin Industries, Inc., Arvinyl Div.	2219
Auburn Manufacturing Co.	1505
Morris Bean & Co.	220
Beemer Engineering Co.	1127
Casting Engineers Division, Consolidated Foundries and Mfg. Co.	2334
Chicago-Allis Manufacturing Corp.	2318



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Disogrin Industries	219
Dixon Sintaloy Inc.	2102
Doehler-Jarvis Division, National Lead Co.	2026
Drop Forging Association	832
International Nickel Co.	2000
Engineered Plastics Inc.	1535
Falstrom Co.	1816
Flexonics Corp.	2421
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Haynes Stellite Co.	1408
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Janney Cylinder Co.	500
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MM Enclosures, Inc., Affiliated with A & P Metal Products Mfg. Corp.	2335
Meehanite Metal Corp.	2226
Metal Powder Industries Federation	1525
Mobay Chemical Co.	1129
Mueller Brass Co.	1405
National Beryllia Corp.	308
National Tube Division, United States Steel Corp.	2104
Ohio Seamless Tube Division of Copperweld Steel Co.	629
O'Sullivan Rubber Corp.	2420
Owens-Corning Fiberglas Corp.	2015
Pennsylvania Fluorocarbon Co., Inc.	1032
The Polymer Corp.	1513
Precision Metalsmith Inc.	231
Pressco Casting and Mfg. Corp.	1302
Raybestos-Manhattan, Inc.	1810
Roehlen Engraving Works	1227
Edwin B. Stimpson Co.	235
Stokes Molded Products Division of Electric Storage Battery Co.	920
Superior Tube Co.	2020
Toyad Corp.	1515
Union Carbide Corp.	1408
United States Rubber Co., Mechanical Goods Division	1324

HYDRAULIC AND PNEUMATIC COMPONENTS

	Booth No.
Aeroquip Corp.	1809
Air-Maze Corp.	1134
Alemite Division, Stewart-Warner Corp.	732
Aluminum Company of America	2032
Anaconda Metal Hose Division, American Brass Co.	1236
Artus Corp.	317
Auburn Manufacturing Co.	1505
Automatic Switch Co.	1438
Beemer Engineering Co.	1127
Benton Harbor Engineering Works, Inc.	1635
Boyle Engineering Laboratory Division of Rotherm Engineering Co., Inc.	2419
Bridgeport Thermostat Division, Robertshaw-Fulton Controls Co.	425
Chemiquip Co.	241
Chicago-Allis Manufacturing Corp.	2318
Cleveland Graphite Bronze Division of Clevite Corp.	2204
Commercial Filters Corp.	504
Control Devices, Minneapolis-Honeywell Regulator Co.	1202
Crane Packing Co.	512
Crawford Fitting Co.	921
D.S.D. Manufacturing Co.	407
De Laval Steam Turbine Co.	833
Disogrin Industries	219
Eclipse Machine Division, Bendix Aviation Corp.	125
Engineered Plastics Inc., American Sinterings Division	1535
Flexonics Corp.	2421
Garlock Packing Co.	2206
Gast Manufacturing Corp.	925
General Controls Co.	1608
Greene, Tweed & Co.	336
Hansen Manufacturing Co.	628
Heim Co.	2113
Hoke Inc.	1536
E. F. Houghton & Co.	1207
Imperial Brass Manufacturing Co.	1606
International Packings Corp.	1309
L & L Manufacturing Co.	1823
Lear, Inc., Instrument Division	339
Leiman Bros., Inc.	1630
Martin Engineering Co.	1903
Mead Specialties Co.	1401
Mobay Chemical Co.	1129
Mueller Brass Co.	1405
New Departure Division, General Motors Corp.	633
C. A. Norgren Co.	918
Parker-Hannifin Corp.	1339
Pic Design Corp., Subsidiary of Benrus Watch Co.	1208
Polymer Corp.	1513
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Raybestos-Manhattan, Inc.	1810
Roller Bearing Company of America	1530
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Rotherm Engineering Co.	2419
Sanders Associates, Inc.	2245
A. Schrader's Son, Division of Scovill Manufacturing Co., Inc.	1831
Screen Products Co.	913
Sealol Corp.	1340
Sigmamotor Inc.	2315
Skinner Electric Valve Division, Skinner Chuck Co.	1813
Snap-Tite, Inc.	825
Stokes Molded Products Division of The Electric Storage Battery Co.	920
Strateflex Inc.	1300
Taylor Devices, Inc.	1116
Titeflex Inc.	408
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Vibro-Plus Products, Inc.	2325
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Weatherhead Co., Fort Wayne Division	1801
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Wooster Division, Borg-Warner Corp.	2213
Worthington Corp.	319

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	Booth No.
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Brass & Bronze Ingot Institute	338
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Chilton Co.	928
Cobehn, Inc.	412
Conover-Mast Publications	1225
Design News	734
Electrical Design News	734
Electrical Manufacturing	1225
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Flexonics Corp.	2421
Florida Development Commission	204
General Fireproofing Co.	2212
Hamilton Manufacturing Co.	2230
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The Industrial Publishing Corp.	1111
Industrial Research	1825
The Iron Age	928
Lead Industries Association	632
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Materials in Design Engineering	2125
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Ponton Publishing Co.	1216
Plan Hold Corp.	1001
Plastics World	1211
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Precision Metal Molding	1111
Precision Specialties, Inc.	301
Product Design & Development	304
Product Engineering	1524
Prudential Industries, Inc.	1916
Purchasing News	734
Riehle Testing Machines Division, American Machine and Metals, Inc.	232
Rogers Publishing Co.	734
Rogers Publishing Co., Technical Services Division	334
Rotherm Engineering Co., Inc.	2419
SKF Industries, Inc.	1932
Sifco Metachemical Inc.	320
Space/Aeronautics	1225
Stacor Equipment Co.	2322
Thomas Publishing Co.	1137
F. D. Thompson Publications, Inc.	229
Unitech Corp.	416
United Shoe Machinery Corp.	924
Universal Drafting Machine Corp.	634
Vibro-Plus Products, Inc.	2325
Web Controls Corp.	1729
Welding Design & Fabrication	1111

1960 ASME DESIGN ENGINEERING CONFERENCE

program in brief

▶ MONDAY, MAY 23 **9:45 a.m.**

New Horizons in Engineering Design

Panel Members

William R. Gall, chief of Design Section, Reactor Experimental Engineering Div., Oak Ridge National Laboratory, Oak Ridge, Tenn.

Varick D. Schwartz, assistant project manager, Army Boiling Water Reactor Project, Combustion Engineering, Inc., Windsor, Conn.

George P. Sutton, chief scientist, Advanced Research Projects Agency, Department of Defense, Washington, D. C.

Elmer P. Wheaton, vice-president—engineering, Missiles and Space Systems, Douglas Aircraft Co., Inc., Santa Monica, Calif.

▶ TUESDAY, MAY 24 **9:30 a.m.**

Reliability

Reliability Prediction as a Design Tool, by *T. C. Reeves*, director of Product Assurance, RCA Defense Electronic Products Div., New York, N. Y. (Paper No. 60—MD-1)

Impact of Reliability on Design, by *H. R. Powell*, member of Senior Staff, Space Technology Laboratories, Los Angeles Calif. (Paper No. 60—MD-2)

New Welding Processes, by *J. J. Chyle*, director of Welding Research, A. O. Smith Corp., Milwaukee, Wis. (Paper No. 60—MD-3)

Metal-Part Fabrication by Explosives, by *Vasil Philipchuk*, manager, Special Projects Dept., National Northern Div., American Potash & Chemical Corp., West Hanover, Mass. (Paper No. 60—MD-4)

Trends and Factors Influencing Hydraulics, by *Edward Brown*, director of engineering, Machinery Hydraulic Div., Vickers, Inc., Detroit, Mich. (Paper No. 60—MD-5)

Hydraulic Fluids—Today and Tomorrow, by *R. L. Leslie*, supervisor, Fluids and Chemistry Group, Research and Development Dept., Vickers, Inc., Detroit, Mich. (Paper No. 60—MD-6)

▶ WEDNESDAY, MAY 25 **9:30 a.m.**

Control Systems

Analysis of Control Systems by Analog Computers, by *W. E. Sollecito*, systems analysis engineer, General Engineering Laboratory, Gen. Elec. Co., Schenectady, N. Y. (Paper No. 60—MD-7)

Computers in Control Systems, by *A. S. Robinson*, assistant chief engineer for advance electronic research and development, Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J. (Paper No. 60—MD-8)

Some Considerations in the Use of High-Strength Steels, by *A. M. Hall*, division chief, Battelle Memorial Inst., Columbus, Ohio (Paper No. 60—MD-9)

Increasing the Performance of Nonmetallic Structural Materials, by *W. E. Dirkes*, chief, Plastics Branch, Materials Laboratory, Wright Air Development Center, Wright-Patterson Field, Ohio (Paper No. 60—MD-10)

Concept of Modular Design for Mechanized Assembly, by *A. A. Lawson*, consulting project engineer, Melpar, Inc., Falls Church, Va. (Paper No. 60—MD-11)

Basic Design Parameters for Automatic Assembly, by *Robert Esken*, supervisor, engineering and sales application, Autometrology Section, Sheffield Corp., Dayton, Ohio (Paper No. 60—MD-12)

▶ THURSDAY, MAY 26 **9:30 a.m.**

Use of Computers in Design

Panel Members

E. F. Magnusson, mathematician, Control Programming, General Engineering Laboratory, Gen. Elec. Co., Schenectady, N. Y.

George Ryckman, supervisor, data processing group, General Motors Research Corp., General Motors Corp., Detroit, Mich.

Aaron Finerman, manager, Digital Computing and Data Processing Div., Republic Aviation Corp., Farmingdale, N. Y.

DESIGN ENGINEERING DIGESTS

Reliability Prediction — Its Validity and Application as a Design Tool..60—MD-1 ...By T. C. Reeves, RCA Defense Electronic Products Division, New York, N. Y. 1960 Design Engineering Conference paper (multilithographed; available to March 1, 1961).

Prognostication of the reliability of complex equipments before these equipments are built or even designed is dealt with in this paper. It is an introductory survey of reliability prediction intended for the engineer who is not acquainted with the subject.

The paper is developed into three main parts:

1 Introduction to reliability prediction, what it consists of, and the conditions which must accompany its intelligent use such as the necessity for designing reliability into products and for continuous reliability evaluation.

2 Validity of reliability prediction.

3 Uses of reliability predictions in operations analysis, maintenance and logistic studies, design, and value analysis.

The author concludes that reliability prediction is not a substitute for the many essential elements of a balanced reliability program, but it is a sound first step until other than paper-work measures are possible.

The Impact of Reliability on Design..60—MD-2...By Harry R. Powell, Space Technology Laboratories, Los Angeles, Calif. 1960 Design Engineering Conference paper (multilithographed; available to March 1, 1961).

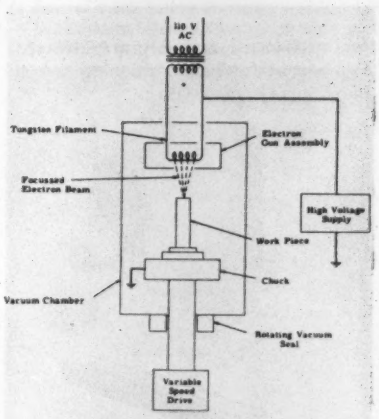
The first real recognition of the reliability problem coincided with the advent of a number of guided-missile programs in this country and with certain increases in the performance requirements for communications and equipment for more conventional weapon systems.

Although statistical terms must still be used in describing the problem, reliability is now recognized as being a physical phenomenon which is basically a design problem.

To the statistician, reliability can be defined as a probability; to the design engineer as an ability. The demand for higher reliability in systems of ever-increasing complexity has had a decided impact on the job of the design engineer.

Design of reliability into equipment by conservatism in design is emphasized. The principles of reliability are described. The mortality curve for the description of failure probabilities as a function of operating time or cycles is presented.

Included are: The meaning of numerical contractual requirements, techniques for the designer including establishment of reliability apportionment, determinations of variations of environment and strength, safety factors, redundancy, component derating, avoiding complexity and overdesign, design review, and scientific design of experiments.



A diagrammatic sketch showing the essential parts of the electron beam welding equipment including an electron-beam gun, a welding chamber, and vacuum equipment controls (60—MD-3).

New Welding Processes . . 60 — MD-3 . . . By J. J. Chyle, A. O. Smith Corporation, Milwaukee, Wis. 1960 Design Engineering Conference paper (multilithographed; available to March 1, 1961 condensed in **Mechanical Engineering**, May, 1960.

The newer metals, developed for the space and atomic age, have characteristics and properties which require new methods of processing and new welding procedures.

The selection of the welding process is governed by the type of metal to be joined, design of weldment, cost of welding, and the engineering and service requirements involved.

Covered in the paper are the broad groups of welding processes:

1 Pressure welding including ultrasonic, high-frequency resistance, foil-seam, magnetic-force, percussion-friction, thermo-pressure, and diffusion-bond welding.

2 Fusion welding including electroslag, electron beam, and arc plasma welding.

3 Brazing welding.

Metal Fabrication by Exposives . . 60 — MD - 4 . . . By Vasil Philipchuk, American Potash and Chemical Corporation, West Hanover, Mass. 1960 Design Engineering Conference paper (multilithographed; available to March 1, 1961; condensed in **Mechanical Engineering**, May, 1960).

The new field of metal-parts fabrication by explosive forces has gained wide interest by both government and industry for many purposes. This field will serve as an adjunct to old and present-day fabricating techniques.

Practically all fabricating operations have been attempted, and many are in use today for specific applications. Higher quality, stricter tolerances, and quicker deliveries can be achieved in many applications.

The main avenues of interest in explosive fabrication are (*a*) sizing, (*b*) forming, (*c*) forging, (*d*) welding, (*e*) compaction, and (*f*) conditioning. Covered in the paper are the methods used, metals and alloys under test, and the changes in material properties.

Current Status of Hydraulic Pumps and Some Trends . . 60 — MD-5 . . . By Edward Brown, Mem. ASME, Vickers Inc., Detroit, Mich. 1960 Design Engineering Conference paper (multilithographed; available to Mar. 1, 1961; condensed in **Mechanical Engineering**, May, 1960).

It is the author's belief that aeronautical, mobile, and industrial hydraulic equipment is in for a change. In the aeronautical field, higher pressures and temperatures are forecast as well as increased pump speeds.

Hydrostatic transmissions in the mobile field will see wider uses because of higher efficiencies and better control. Electro-hydraulic servo systems will continue to expand in the industrial line and variable-speed drives will be more widely used. Standardization will reach a new high in the near future.

Hydraulic Fluids—Today and Tomorrow . . 60—MD-6 . . . By R. L. Leslie, Vickers Incorporated, Detroit, Mich. 1950 Design Engineering Conference paper (multilithographed; available to March 1, 1961).

Hydraulic fluids are available that meet practically all hydraulic applications; they may be selected from an almost limitless number of materials that are liquid over the required working range of temperature and pressure.

This discussion of the state-of-the-art of hydraulic fluids emphasizes the application of fluids. Principal operating requirements of the systems, and the governing characteristics of the fluids used for these various applications are given to illustrate the major reasons for their selection. The fluids are discussed under three major fields of usage: (*a*) industrial, (*b*) mobile, and (*c*) aircraft and missile.

Analysis of Control Systems by Analog Computers . . 60—MD-7 . . . By W. E. Sollecito, General Electric Company, Schenectady, N. Y. 1960 Design Engineering Conference paper (multilithographed; available to March 1, 1961).

The analysis and design of control systems can be broken down essentially into three main parts: problem definition, equation solution, and solution evaluation. It is in the area of equation solution that analog computers are invaluable. They shrink the time and effort in solving those equations which can be solved by hand calculations and bring into the realm of feasibility equation solutions which are unsolvable by written calculations for practical purposes.

This paper presents the fundamentals of the analog computer, shows that it is an engineering tool which reduces time and effort in obtaining solutions to feedback control systems engineering problems. The computer solution, which is easily recorded on strip charts, reveals the transient and steady-state behavior of the system under study.

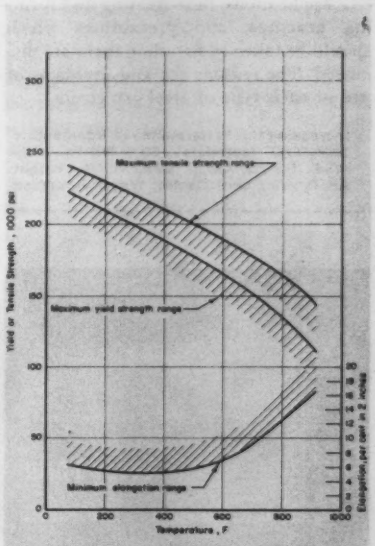
Tables of commonly encountered transfer impedances and nonlinear simulation networks are presented for ready reference.

Computers in Control Systems . . 60—MD-8 . . . By A. S. Robinson, Bendix Aviation Corporation, Teterboro, N. J. 1960 Design Engineering Conference paper (multilithographed; available to March 1, 1961).

Computer control is becoming increasingly important and in one decade has reached a point of maturity that qualifies it for wider application. The art of electronic digital computation has now grown, slowly but steadily, with emphasis on improving techniques for the synthesis, analysis, and simulation of complex systems (aided by analog and digital computers) and toward refinements in established analog control technology.

Basic considerations associated with the coming decade of computer control are presented. Major advances in the computer control art are possible, based primarily on digital computing techniques, but to achieve these advances efficiently and rapidly the combined efforts of both digital computing and control engineering are needed.

Control engineers and their sources of financial support hold the key to this problem in that computer art has already advanced to the point where it is immediately usable in advanced control systems, whereas a major reorientation and expansion of effort in control engineering is required before the most efficient means for using these techniques can be specified.



Some typical short-time, elevated-temperature tensile properties of semi-austenitic precipitation-hardenable stainless steels are illustrated by these curves (60—MD-9).

Some Considerations in the Use of High-Strength Steels . . 60 — MD-9 . . . By A. H. Hall, Battelle Memorial Institute, Columbus, Ohio. 1960 ASME Design Engineering Conference paper (multilithographed; available to March 1, 1961).

During the past 15 years several families of steels have been evolving which are capable of being used at the comparatively high levels of 180,000 to 300,000-psi tensile strength. These species of steels include the low-alloy hardenable types, the chromium hot-work die (H-11 and H-13) steels, the martensitic stainless steels, the semiaustenitic precipitation-hardenable, and the cold-rolled austenitic stainless steels.

The increasingly rigorous demands of the aircraft and missile industry have constituted the major impetus behind development of such steels. Demand for materials of ever higher strength is insistent. Applications for the ultrahigh-strength materials are critical by nature; the specifications are necessarily stringent; and the utmost in performance is demanded of the material.

As experience with the use of these families of steels at very high-strength levels has accumulated, improved methods of making and handling them have been developed. The advantages and disadvantages of each class of steel are better understood, and the steels themselves are constantly being improved. Though many problems remain, many have been solved.

In this paper, mechanical properties of these steels at both room and elevated temperatures are presented. The forms in which these steels are available, illustrative applications, heat-treating and forming practices, and precautions which should be taken in handling them are discussed. The reasons for and problems of use of each type of steel are given.

Increasing the Performance of Nonmetallic Structural Materials . . 60 — MD-10 . . . By W. E. Dirkes, Assoc. Mem. ASME, Wright Air Development Center, Wright-Patterson Field, Ohio. 1960 Design Engineering Conference paper (multilithographed; available to March 1, 1961).

Nonmetallic structural materials are receiving increased attention in military and nonmilitary product designs. Expanding uses are due both to the increasing experience of designers and the inherent advantages of the various materials.

This paper has been prepared to describe a few of the advantages available from nonmetallic structural materials, particularly composite materials, and to present an approach for obtaining optimum properties from the materials now available.

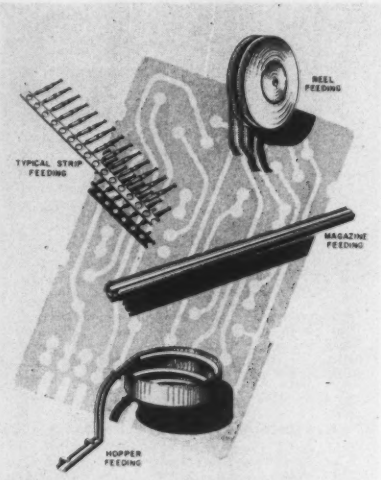
Nonmetallic structural materials include primarily the glass-fiber-reinforced plastics and adhesives for bonding structural materials. Other types which are used fairly extensively are: (*a*) sandwich construction, (*b*) ablation materials, (*c*) composite materials, and (*d*) materials systems. These types of materials categories overlap considerably and although all of them are mentioned in this paper, the illustrations have been selected to describe some of the advantages of composite materials.

The Concept of Modular Design for Mechanized Assembly . . 60—MD-11 . . . By A. A. Lawson, Melpar, Inc., Falls Church, Va. 1960 ASME Design Engineering Conference paper (multilithographed; available to Mar. 1, 1961).

This paper points out the possibilities of extending the basic concept of modular construction and production techniques, such as are used in the electronic industry, into other fields—especially in mechanical equipment.

Benefits derived from this technology begin at the design phase and continue through the production operations. The prime objectives are to obtain increased reliability and economic savings.

Modules are building blocks and are manufactured to permit interchangeability, and general usage in more than one equipment, or system. Five basic units for mechanized assembly are involved: Component feeding, positioning, assembling, power, and control.



The component feeding unit generally has two functions: To store the components and to bring them into the assembling position. It is an integrated unit and should be designed as such. Some typical methods of component feeding are shown (60—MD-11).

Designing Products for Automatic Assembly . . 60—MD-12 . . . By R. L. Esken, Sheffield Corporation, Dayton, Ohio. 1960 Design Engineering Conference paper (multilithographed; available to March 1, 1961; condensed in **Mechanical Engineering**, May, 1960).

The role product design plays in automatic assembly is outlined. Some of the problems met in designing products for automatic assembly and their solutions are presented.

The degree to which automatic assembly can be used depends on the incorporation into the design of each component characteristic for mechanical conveying, feeding, positioning, and fitting.

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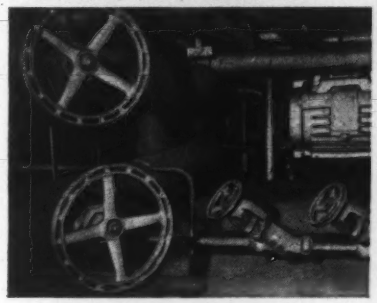
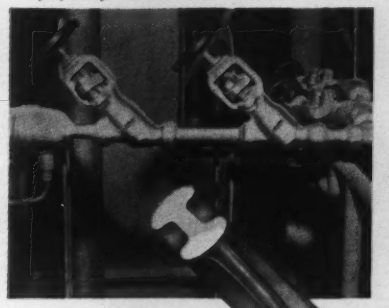
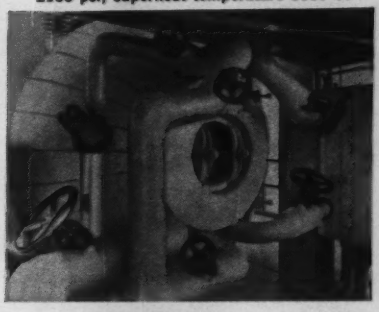
● Four of many Yarway Welbonds installed in large eastern public utility plant. Steam pressure 1850 psi; temperature 1000°F.

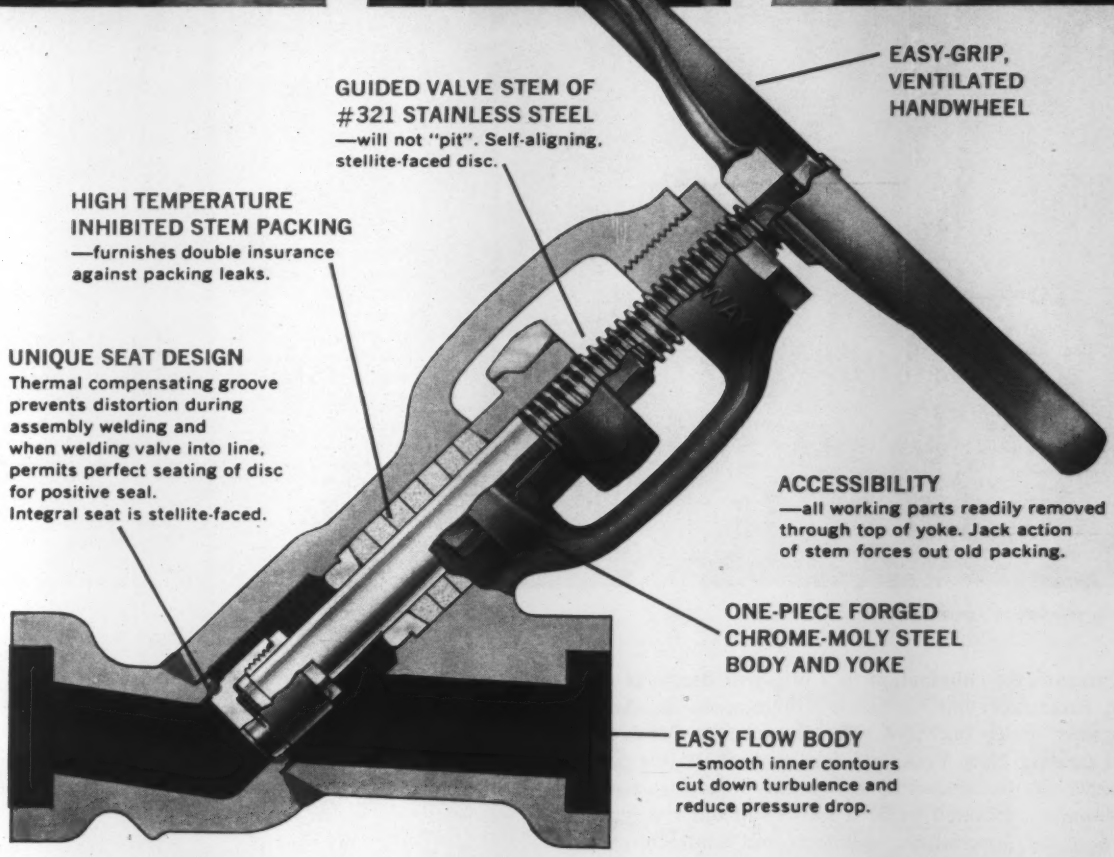


● Four Yarway Welbonds on main steam line to turbine at southern power plant. Press. 2310 psi; temp. 1000°F. Over 100 Welbonds here.



● Six of 900 Yarway Welbonds at southwest utility. Boiler drum pressure in this plant—2150 psi; superheat temperature 1005°F.




EASY-GRIP, VENTILATED HANDWHEEL
GUIDED VALVE STEM OF #321 STAINLESS STEEL
—will not "pit". Self-aligning, stellite-faced disc.
HIGH TEMPERATURE INHIBITED STEM PACKING
—furnishes double insurance against packing leaks.
UNIQUE SEAT DESIGN
Thermal compensating groove prevents distortion during assembly welding and when welding valve into line, permits perfect seating of disc for positive seal.
Integral seat is stellite-faced.
ACCESSIBILITY
—all working parts readily removed through top of yoke. Jack action of stem forces out old packing.
ONE-PIECE FORGED CHROME-MOLY STEEL BODY AND YOKE
EASY FLOW BODY
—smooth inner contours cut down turbulence and reduce pressure drop.

WHY YARWAY WELBONDS ARE SPECIFIED FOR HIGH PRESSURE VALVE JOBS

WELBOND valves—because they are designed specifically to provide better, longer maintenance-free service in high pressure/high temperature power plants—have won resounding acceptance from boiler room operators everywhere. WELBOND performance speaks for itself.

Look at the advantages above! Try WELBONDS in *your* plant—for high pressure boilers, in all general services requiring small valves (¼" through 2½"). Write for free Yarway Bulletin B-454.

YARNALL-WARING COMPANY, 100 Mermaid Ave., Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY
A MARK OF QUALITY IN STEAM ENGINEERING

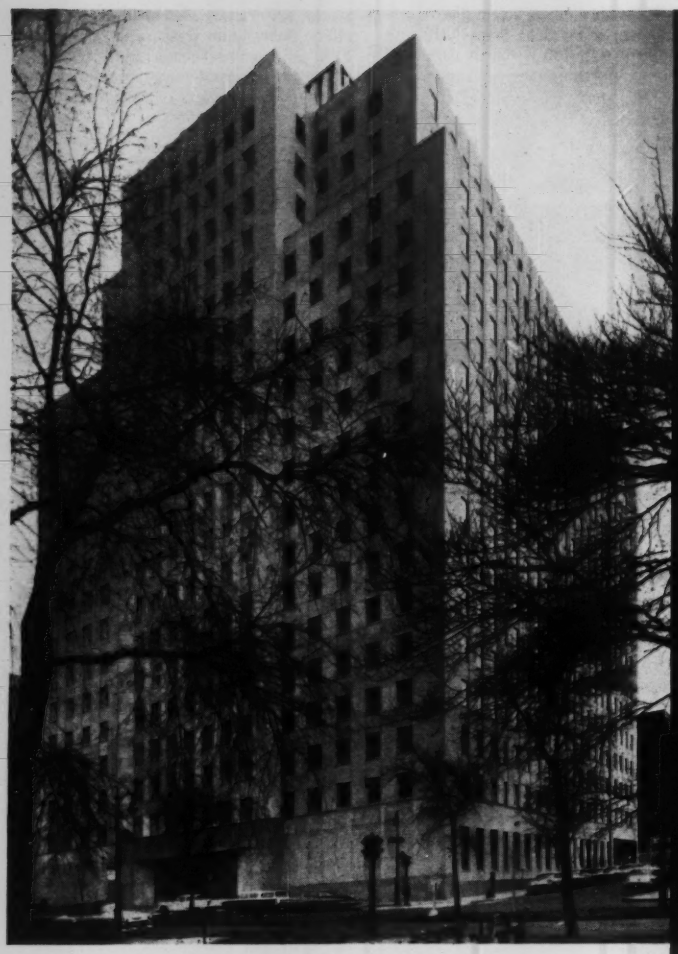


Photo courtesy of Turner Construction Company

Built to an "Only the Best" specification

. . . equipped with JENKINS VALVES

The Interchurch Center
New York City

Poised on a bluff 100 feet above the Hudson River, this $21 million structure houses 2,000 individuals representing 144,000 local Protestant and Orthodox congregations embracing 40,000,000 members in the United States. Its imposing limestone facing alone represents a substantial investment in beauty as well as permanence.

Architects: Collens, Willis & Beckonert – Voorhees Walker Smith Smith & Haines. *General Contractor:* Turner Construction Company. *Plumbing Contractor:* C. H. Cronin, Inc. *Heating, Ventilating, Air Conditioning Contractor:* Raisler Corporation.

A magnificent culmination to a fifty-year dream of bringing Protestant and Orthodox communions in America together under one roof, The Interchurch Center is an outstanding New York building, as well. It is especially noteworthy for an overall high quality in construction and equipment. Planned to be a symbol of unity that would endure for generations, architects and contractors could be satisfied only by "the best" in everything.

When it came to valves for both the central air conditioning system and the heating system with its three low pressure boilers, all building factors agreed on JENKINS. They could be sure Jenkins Valves would deliver an unusual measure of long-time efficiency and economy. And, as practical planners, they appreciated the fact that Jenkins Valves cost no more than any good valves.

When YOU choose valves, remember that you pay no premium to specify the valves so often favored by the country's top building authorities. Jenkins Bros., 100 Park Ave., New York 17.

SOLD THROUGH LEADING DISTRIBUTORS EVERYWHERE

Jenkins Iron Valves on water lines of condensor

JENKINS
LOOK FOR THE JENKINS DIAMOND
VALVES
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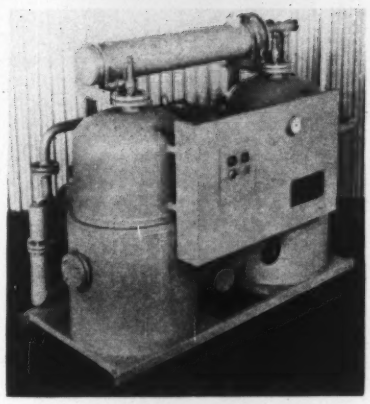
NEW EQUIPMENT



Gas Dryer

A series of drying equipment for compressed air, or other gases, designated Type BZ, has been announced by the Pittsburgh Lectrodryer Div., McGraw-Edison Co.

Planned particularly for instrument-air service, the Lectrodryers are simply and functionally designed with interchangeable parts and adequate instrumentation. Operation is completely automatic. Working on a 6-hr cycle, they adsorb moisture, heat for regeneration, and cool with no more attention than occasional lubrication. —K–1

New Truarc Ring-O-Mat

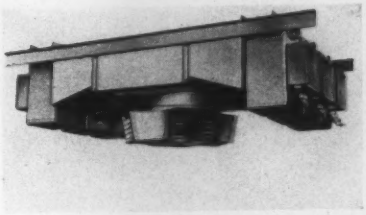
An automatic retaining ring assembly machine designed to speed production, eliminate assembly stations, and reduce manufacturing costs has been developed by Waldes Kohinoor, Inc. Called the Truarc Ring-O-Mat, it is intended for high-speed, mass-production assembly of Truarc radially installed Series 5103 crescent rings, Series 5133 E-rings, and Series 5144 reinforced E-rings.

A single Ring-O-Mat assembly station can be equipped to install virtually any number or combination of ring types and sizes in one assembly operation. The number of rings which can be assembled simultaneously is limited only by the accessibility of ring grooves in the work piece. —K–2

Shock-Testing Machine

A new 16750 Varipulse shock-testing machine made by Barry Controls, Inc., is designed for testing precision electronic, mechanical, or electrochemical components. It produces a wide variety of precise and undistorted half-sine, sawtooth, and square-wave shock pulses that are reproducible in test after test.

The machine operates on the free-fall principle with push-button control. Set-up time is negligible and there is automatic cycling and repositioning of the test platform to preset drop height. No special foundations or auxiliary thrust sources are required. Maximum drop height is 38 in. The machine can accommodate an 8-in. cube weighing up to 20 lb. —K–3

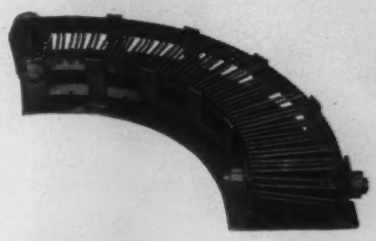


Gas-Fired Heaters

Gas-fired duct-heater assemblies for complete or supplemental heating of industrial and commercial buildings have been added to the product line of L. J. Wing Mfg. Co. The assemblies consist of two, four, or six gas-fired duct heaters, a plenum chamber, a motor-driven fan, and a fixed or revolving discharge.

The self-contained units which need little vertical space may be mounted in the truss area of a building, and require no connections to duct work. With revolving discharges, they provide a constantly-moving stream of warm air to the floor, which flows around and under columns, machines, stacked materials, and other obstructions, for even heating without hot or cold spots.

The units are available in five sizes with output capacities from 368,000 to 1,104,000 Btu per hr. Four revolving and four fixed-discharge designs suit installations with mounting heights up to 50 ft, and coverage of floor areas up to 132 × 132 ft by a single unit. The duct heaters are approved by the American Gas Association. The highly-efficient, non-overloading Wingfoil fans are driven by totally enclosed, glass-insulated motors. —K–4



Circular Chain

A circular chain with tubular cross members is made by Acme Chain Corp. in $^1/_2$-in-pitch (No. 40) and $^5/_8$-in-pitch (No. 50) sizes, and furnished with or without pin extensions or attachments. Standardized radii, upon which the chain operates, are 15, 20, and 30 in.

Where sanitary noncorrosive qualities are required, the cross flights are available either in galvanized-bright-zinc or stainless-steel finishes, as well as all stainless steel.

Special design of the chain pins and maximum hardening of all wearing surfaces together with incorporation of an actual projected bearing area incorporated in each strand of chain assure long life. —K–5

Servovalve-Motor Package

A servovalve hydraulic-motor package announced by Vickers Inc. Div. Sperry Rand Corp. is used to control accurately velocity and position of radar drives, missile guide vanes, gun-turret drives, reels, winches, hoists flight controls, stabilization devices and other aircraft, missile, and ground-support applications. The servovalve modulates flow to the motor producing speeds proportional to electrical input signals.

Miniaturized the servovalve weighs only 0.53 lb, which holds the valve-motor package size and weight to a minimum dry-package weight of 2.7 lb and occupancy of approximately 60 cu in. of space. Models with integral relief valves weigh 2.9 lb with no sacrifice of additional length.

The package is designed to cover any speed range from 10 to 20,000 rpm with a maximum output running torque of approximately 30 in-lb at 3000-psi supply pressure.

A differential current of only ± 8 milliamp actuates the valve control spool. Valve configuration assures a high degree of linearity, low null shift with temperature, low hysteresis, and increased reliability due to elimination of unnecessary tubing and fittings. —K–6

END WATER LEVEL WORRIES

in those medium pressure boilers

Here's the great combination that takes all the worries and troubles out of water level and feed pump control for the many medium pressure boilers—boilers with steam pressures up to 150 psi.

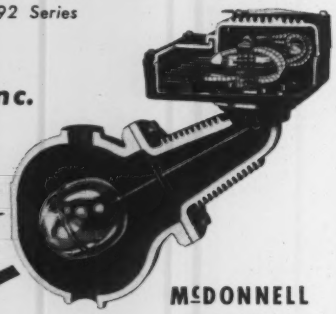
The drawing shows the simple hook-up. McDonnell No. 150 controls the boiler feed as it should be controlled—directly from the boiler water level. This holds the water level within the close limits that assure maximum steaming efficiency and fuel economy. Any deficiency in the returns is at once replaced by the McDonnell No. 27TA Make-up Water Feeder installed on the receiver.

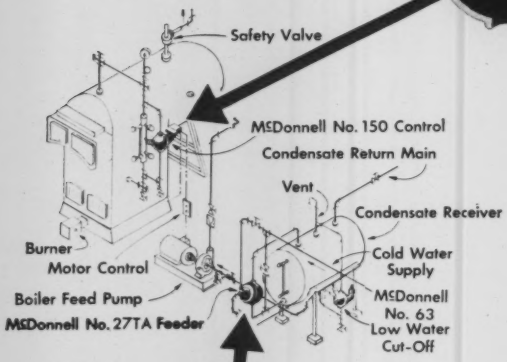
An extra switch on the No. 150 provides circuits for cutting off burner and sounding low water alarm—a final safeguard from emergency conditions such as current interruption in the pump circuit or failure of make-up supply.

Ask for engineering data covering all conditions. For boilers up to 250 psi. ask about the new 92 Series Pump Control.

McDONNELL & MILLER, *Inc.*
3506 N. Spaulding Ave.
Chicago 18, Ill.

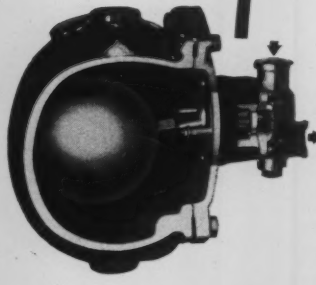
Doing One Thing Well





McDONNELL No. 150 PUMP CONTROL

The most widely used, time proved control of its type—for boilers up to 150 psi. Underwriters' Listed. Has two mercury switches—one for controlling feed pump and one for low water cut-off and alarm. Packless construction features heavy monel sylphon. Switch leads have porcelain bead insulation. Also available with water column type body—No. 157.



McDONNELL No. 27TA MAKE-UP WATER FEEDER

Has large water feeding capacity which permits locating the No. 27TA at a relatively low point on the receiving tank; this provides adequate space for return condensate, preventing wasteful overflow. Sturdy construction withstands turbulence in receiver. For tank pressures to 35 lbs., water supply pressures to 100 lbs. McDonnell Make-up Feeders also include flange-mounted types.

Your Jobber Stocks Them

McDONNELL
Boiler Water Level Controls

Boiler Water Feeders • Low Water Fuel Cut-Offs • Pump Controllers • Relief Valves
Flow Switches • Related Liquid Level Controls for Tanks, Stills, Air Conditioning Systems

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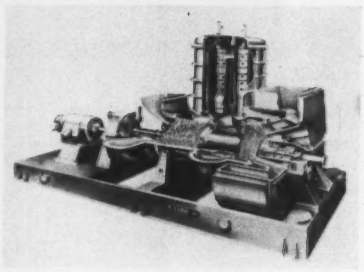

Gas Turbine

An open-cycle, single-shaft gas turbine with a NEMA rating of 9000-bhp designated Model 305-S has been introduced by Clark Bros. Co., one of the Dresser Industries. Designed to achieve substantial savings in initial equipment cost, transportation, floor space, foundation and installation expense, it burns either liquid or gaseous fuels and is capable of continuous operation under full-load at 5000 rpm.

In applications requiring limited speed flexibility, the 305-S provides a low-cost, reliable source of rotative power for centrifugal compressors, power generators, and liquid pumps with a minimum number of parts. High rotating inertia insures minimum speed variations under transient-load conditions.

At rated speed, the axial compressor delivers a mass flow of 135 lb per sec. Turbine-inlet temperature is held under 1400 F to insure extra long life and a substantial margin of operating safety.

The turbine is completely air cooled—pressurized air is bled off the axial compressor to cool high-temperature components, while cool-air envelopes between inner and outer skin surfaces reduce heat loss and minimize external temperatures wherever possible. An optional air-cooled lube oil cooler can be furnished to permit operation that is completely free of water requirements. **—K–7**

End Milling

A line of two-flute, single-end Thriftmills has been added to the Brown and Sharpe Mfg. Co. four-flute Thriftmill already in wide use. Thriftmills are ground from solid, metallurgically tested high-speed steel. They produce more quickly, efficiently and at up to 20 per cent less initial cost than conventional end mills.

The two-flute Thriftmill is single-end, with 30-deg helical flutes, right-hand cutting. The shank is made same-size diameter as cut for greater tool rigidity and longer life.

Recommended for most conventional end-mill operations it is especially suited for profiling, peripheral milling, and general end-milling work. It is available from stock in six sizes, 1/8, 3/16, 1/4, 5/16, 3/8, and 1/2-in. **—K–8**

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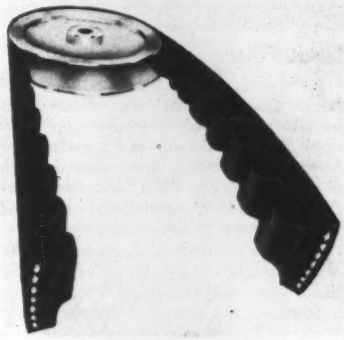
NEW EQUIPMENT
LATEST CATALOGS



V-Belt

A unique fully molded, fully jacketed notched V-belt presently available only to original-equipment manufacturers, is announced by Raybestos-Manhattan, Inc., Manhattan Rubber Div.

Quiet, vibrationless, cool running characteristics, ruggedness and greater flexibility, permit the CX V-belt to run smoothly over smaller pulleys. In addition, fully molded and fully jacketed construction eliminates flex-cracking, and greatly increases fatigue resistance. The firm, fully fabric-covered body also resists cross-sectional distortion, maintains lateral stability, and resists changes in effective length. It is claimed to outlast other belts as much as eight to one.

The high-tensile-strength cord members are micropositioned and formed into an arch through a patented molding process which results in increased sidewall pressure, providing more grip, little or no slippage, and more uniform pitch. —K-9

Pulleys

Low-cost variable-speed pulleys utilizing smaller-top-width belts and sheaves have been developed by Lovejoy Flexible Coupling Co. for applications where economy is a factor. The series consists of six sizes ranging from fractional to 5 hp, with speed ratios up to 4 to 1.

The pulleys can be easily and quickly installed on old or new equipment, and offer the advantage of instant speed changes while equipment is running, the company states. —K-10

Silicone Product

Silastic RTV 731, developed by Dow Corning Corp. is a single-component fluid silicone rubber that requires no premixing, and cures or vulcanizes at room temperature. The product is still very new and somewhat untried, but holds promise in a wide variety of applications. Evaluative samples are available. —K-11

When the Job Calls for Bellows,
Assemblies Cost You Less!
Engineered to *your* design requirements, Fulton Sylphon® bellows assemblies save you time and headaches . . . and reduce production costs! Eliminate costly, tedious assembling of components—and necessary in-plant testing—by specifying *complete* Fulton Sylphon assemblies. One-source manufacturing responsibility, more economical purchasing . . . and every assembly is pilot-tested before it leaves the plant!
For suggestions on how bellows assemblies could fit into your product picture—write for Catalog EK-R.
Mr. Controls
Robertshaw-Fulton
CONTROLS COMPANY
FULTON SYLPHON DIVISION
Knoxville 1, Tennessee

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Thread Grinder

The Ex-Cell-O Corp. has produced a precision internal-thread grinding machine equipped with a range of grinding wheel speeds to suit a variety of work.

Spindle speed, normally 15,000 rpm can be raised or lowered by changing pulleys. To facilitate grinding of small work, a Bryant high frequency spindle capable of a wheel speed adjustable between 42,000 rpm and 60,000 rpm is provided. The two spindles are readily interchangeable. A tank and pump water-cooling unit effectively maintains constant working temperature.

This Style 39-A precision internal thread grinder performs all the normal operations found on a standard Ex-Cell-O machine, including the grinding of multiple-lead threads tapers, radius forms and right and left-hand threads of almost any type. Except for loading and resetting the wheel to initial grinding position, the machine cycle is fully automatic, permitting maximum production. **—K-12**

Hex Keys

Two new hex keys for the 1960-type cap screws replace the 36 series made by Set Screw & Mfg. Co. The two additional keys are required for cap-screw sizes 6 and 8. These have both been changed in the socket dimensions as the result of an industry-wide effort to improve cap screws. **—K-13**

Servo Motor

A servomotor integrally cast in thermosetting epoxy resin, made by Cedar Engrg. Div., Control Data Corp. is impervious to salt spray and corrosive fluids, and offers higher resistance to physical shock.

The recently perfected encapsulating technique makes possible lighter weight and increased resistance to environmental conditions. Standard servomotor mounts are available as well as a unique O-ring mounting which seals the motor and gear train from coolant fluids or gases in applications where the unit is immersed. **—K-14**

Liquid Filter

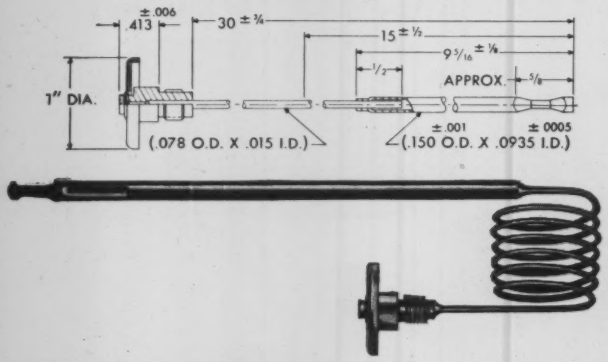
A small-size filter unit made by R. P. Adams Co., provides a low-cost filter package for pilot-plant or development applications, yet is designed for any process where small flows are involved. Some typical applications are process water, industrial water, brine solutions, demineralized water, and a wide variety of process fluids.

The filter elements are available in a choice of Adams Poro-Stone, Poro-Carbon, Micro-Maze (sintered metal) or Poro-Edge—depending on the degree of filtration desired. If required, diatomaceous earth or similar filter aid can be used to provide microscopic-size passages for filtering out the smallest particles including many bacteria and algae.

Complete cleaning by backwashing is greatly facilitated by "pressure-dome" design. On-stream flow rates are 1 to 2 gpm per sq ft of filter area, although under some conditions as much as 4 gpm per sq ft is possible. Units are available in four sizes with 14, 18, 30, and 40 sq ft of filter area. **—K-15**

TEMPERATURE SENSOR

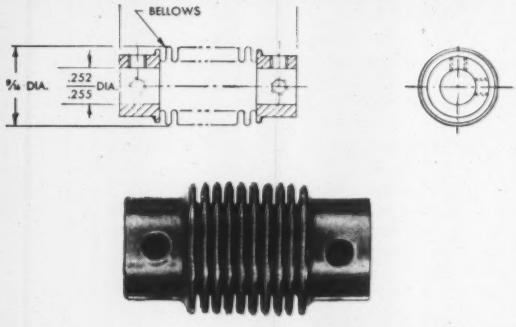
ACCURATE, NO-DRIFT CONTROL FOR APPLIANCES SOLVED BY ROBERTSHAW DIASTAT® ASSEMBLY



Temperature sensing elements like this one for a range oven control offer permanent accuracy with no drift, consistent calibration, no resetting, long life and savings in space, weight and unit cost. Ambient temperature sensing devices are unnecessary in most applications. Typical stroke is .035″ for a 1″ diameter stainless steel diaphragm. Ideal for sensing temperatures up to 650°F. All units are custom engineered and delivered as pre-assembled "packages," tested and ready for mounting. WRITE FOR BULLETIN D605

FLEXIBLE COUPLING

ELIMINATE BACKLASH, END-PLAY! ABSORB VIBRATION, SHOCK WITH ROBERTSHAW FLEXIBLE COUPLINGS



Servomechanisms, instruments and similar drive and control systems are the big users of these small, flexible units. Ideal for guarding against misalignment friction and bearing wear problems. Save space and weight. Cut down noise. Simplified design utilizes seamless metallic bellows, in choice of several metals, connected to two hubs. Sizes from 15/32″ O.D. Stock sizes accommodate shafts from ⅛″ to ½″. Other sizes custom-engineered. **WRITE FOR DATA SHEET D805**

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

End-Finishing Machine

A Model 660 end-finishing machine has been introduced by Pines Engineering Co. The machine simultaneously removes burrs, chamfers, and faces the ends of tubing, pipe, and rod. A variety of light drilling, reaming, and forming operations are also handled with appropriate tooling. —K-16

Ratcheting Wrench

An open-end wrench with ratcheting action is being manufactured by Royal Tool Co. and marketed industrially by the Bristol Co.

A spring-activated pawl provides better gripping action against a nut, and releases for ratcheting action. In operation, the pawl slides against the flat jaw of the wrench to seat the wrench against the nut; locks the nut in the wrench; releases the nut for ratchet action; and then relocks it in the wrench. —K-17

Hand Pump

The Nalge Co. announces a completely new hand pump fabricated entirely from Nalgene, Type H (linear, low-pressure, high-density) polyethylene for chemical resistance and rigidity.

A small "drip well" prevents liquid from running down the side and coming in contact with the operator's hands. The spout can be turned up after dispensing to eliminate the hazard of dripping, or be removed for shipping or storage.

The straight-line design and self-cleaning ball-valve arrangement assure smooth unimpeded flow, hydraulic efficiency, and long life. The pump will handle slurries as well as clear liquids. No oiling or screen cleaning is required and there is no leather to dry out. Small lugs on the bottom prevent the pump from resting on the floor of the container and permit complete emptying of the drum.

The pump can be inserted 34 in. into a container, capacity is approximately 6 strokes per gal (20 oz), and OD is $1^{13}/_{16}$ in. —K-18

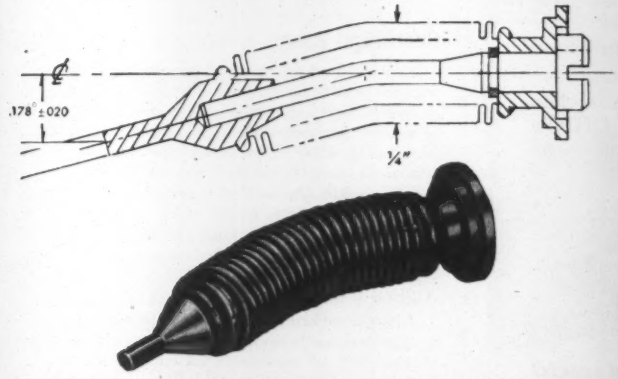
Filled-Teflon Piston Rings

Filled-Teflon piston rings in butt-joint, step-joint, scarf-cut, or solid design are being marketed by Garlock Packing Co. They provide nonlubricated service to seal reciprocating, oscillating, and rotary motion of both external and internal cylindrical surfaces against the leakage of liquids or gases. Matched filled-Teflon rider rings are also available for use with the piston rings where long stroke or heavy pistons require additional support.

The specially processed carbon-filled Teflon has a lower coefficient of friction than any other solid material. The rings have exceptional thermal stability and are suitable for continuous service from −420 to +500 F. They are tough and abrasion-resistant and have the ability to imbed hard foreign particles without adversely affecting the cylinder life or the ring itself. Mechanical strength and dimensional stability are excellent. —K-19

MINIATURE BELLOWS

SAVE SPACE AND WEIGHT WITH RUGGED, MINIATURE ROBERTSHAW FORMFLEX* BELLOWS



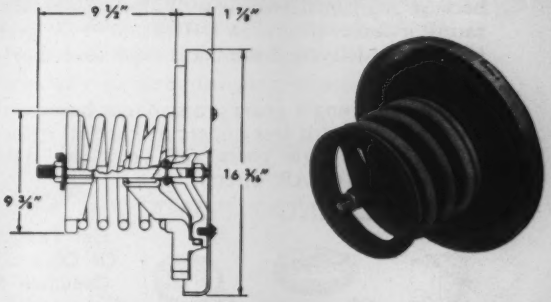
Now . . . hydraulically formed seamless metallic bellows as small as ⅛" O.D.! These miniature Formflex units, along with ¼" and 5/16" O.D. sizes, permit further miniaturization in aircraft, missiles, instruments and other equipment. All sizes are available in a wide range of metals to provide the desired strength and performance characteristics. Ideal in assemblies that react to or compensate for pressure and temperature changes. *Custom*-engineered in any quantity you may require.

WRITE FOR BULLETIN D10S

*Registration pending

PRESSURE RELIEF VALVE

VENTS PRESSURE BUILD-UP IN TRANSFORMERS, TANKS . . . RESEALS AUTOMATICALLY WITH NO RESETTING!



Now you can forget breakaway seals that have to be replaced each time dangerous high pressure build-ups are relieved. Robertshaw Pressure Relief Valve operates instantaneously. No moisture or contaminants can enter vessel during blow-off or automatic resealing and resetting. No periodic inspections necessary.

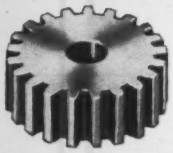
WRITE FOR ENGINEERING DATA SHEET D90S

Robertshaw

BRIDGEPORT
THERMOSTAT DIVISION
ROBERTSHAW-FULTON CONTROLS CO.
Milford, Conn.

BOOTH 425 AT THE DESIGN ENGINEERING SHOW

20% Stronger GEAR TRAINS



with OHIO 20° P.A. Gears

You can add as much as 20% more strength to the gearing in your product, simply by switching to OHIO 20° pressure angle gears.

Ohio offers the only complete line of 20° P.A. gears which have exactly the same face width as the older standard 14½° P.A. type.

Existing designs need not be altered to gain this extra strength because you can substitute a 20° P.A. gear train without changing ratios or center-distances. OHIO's 20° P.A. gears are available for immediate delivery from local stock and they cost no more than 14½° gears.

20° pressure angle gears are stronger because they have a thicker tooth profile with less undercut. For full information on OHIO's 20° pressure angle gears, call your local OHIO distributor or write OHIO GEAR direct.

Get Your Copy Of Ohio Gear's Complete Stock Gear and Speed Reducer Catalog.

Manufacturers of gears and speed reducers - both stock and special

Ohio OHIO GEAR Company

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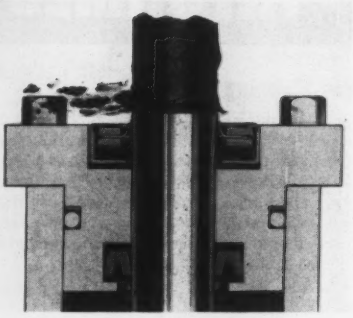

Wiper-Scraper Seal

Both a rod wiper and a rod scraper are incorporated within a single unit announced by Chicago Rawhide Mfg. Co. Called the SC wiper scraper seal, it is said to provide effective, low-cost protection for packings on reciprocating shafts and hydraulic cylinders exposed to heavy-dirt conditions.

The scraper effectively removes frozen or caked mud, tar, and other materials firmly stuck to the rod, thereby prolonging packing life, protecting bore finishes, and reducing equipment downtime. The seal consists of a thin brass scraper ring in tandem with a pliable Sirvene (synthetic rubber) wiping member, both firmly clamped within a compact steel shell.

The OD of the scraper ring has sufficient play within the outer shell to permit realignment and tolerance of any off-center conditions of the rod. No special machining for grooves or retaining rings in steel cylinders is required.

Cost of the seal is said to be comparable to that of a conventional spring-loaded, shaft-type oil seal. It is available in stock sizes for shafts ranging from ½ to 6-in. in diam. **—K-20**

Centrifugal Pump

Ideally suited for chemical-circulating and transfer work in pilot plants and laboratories, or on equipment that requires the circulation of small quantities of clear corrosive liquids. Goulds Fig. 3604 ¾-in. centrifugal pump is now available in Hastalloy-C Alloy (ISO-321) as well as 316 (ACI CF-8M) stainless steel. In these constructions the three principal parts of the pump, the casing, impeller, and adapter are furnished in these materials by Goulds, Pumps, Inc. All other parts are AISI304 stainless steel.

A Hypalon O-ring provides an effective seal against leakage between casing and adapter without use of gaskets, while the carbon, Teflon, and ceramic elements in the mechanical seal provide excellent corrosion resistance. Capacities range up to 16 gpm with heads up to 28 ft. Standard drip-proof or explosion-proof motors are available. Ask for Bulletin 624A4. **—K-21**

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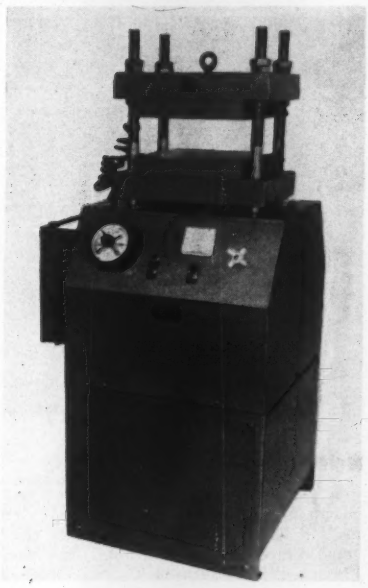

Press

A 30-ton hydraulic-laboratory motorized press introduced by Wabash Metal Products Co., features convenient "easy reach" working height. All dials and controls are mounted on a sloping panel on the instrument console. Both upper and lower platen are electrically heated, controlled independently. Power for the hydraulic ram is supplied by a compact "power pack" in the base. The ¾-hp motor, available in 220-volt, 60-cps 1-phase or 220/440-volt 60-cps 3-phase operation.

Other features include chromium-plated columns, precision jig-bored platen guide holes, quick-opening and closing of platens, holding of platens indefinitely at a pressure range. —K-22

Pilot Relief Valve

Parker Hannifin announces the Hydrelief as a major advance in pilot-operated relief valves. It is designed for outstanding reliability in hydraulic systems that must operate in remote places where there may be difficulties in trying to follow a frequent or regular maintenance routine.

Designated model number VPR3P3F, the capacity is 30 gpm in offset mounting and 20 gpm when mounted in-line. Pressure-adjustment range is from 250 to 3000 psi. Pressure rise between cracking or opening of the relief to full flow at the maximum rated capacity and pressure is only 6 per cent. —K-23

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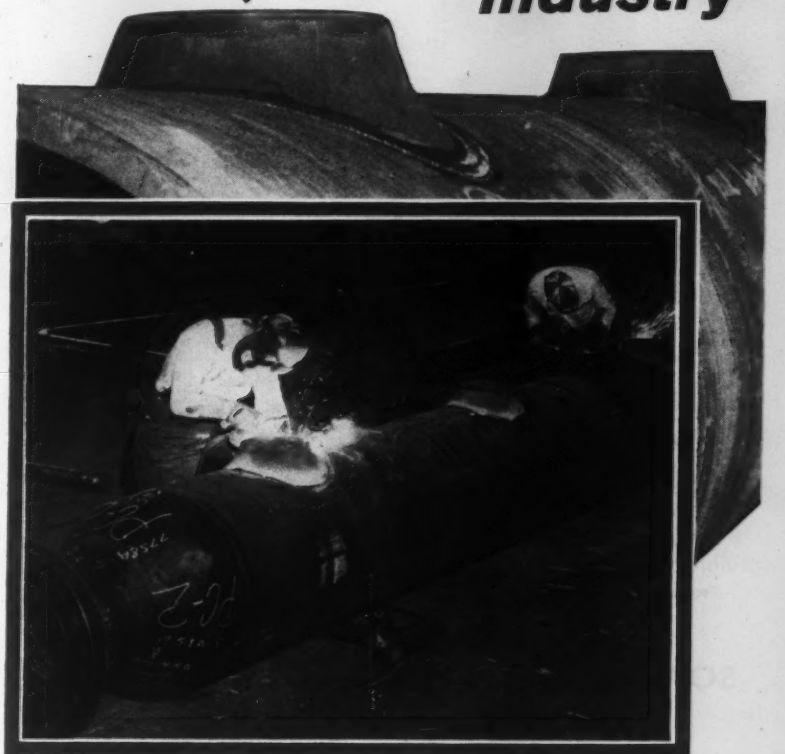
BONNEY SWEEPOLETS Pat. Pend. ®

...are SWEEPING the pipeline industry



The Bonney Sweepolet is an integrally reinforced insert butt welding pipe fitting specially designed for stress free branch connections on high pressure pipelines.

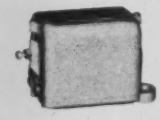
WRITE FOR CATALOG S-1A

BONNEY FORGE and Tool Works
ALLENTOWN, PENNSYLVANIA

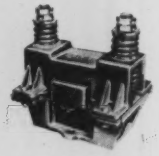
BONNEY

SYNTRON cost-reducing EQUIPMENT

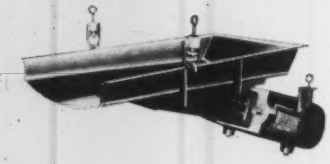
of proven dependable quality



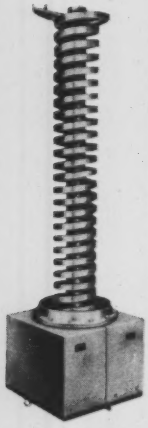
BIN VIBRATORS



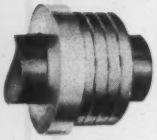
VIBRATORY FEEDERS



PARTS FEEDERS



SPIRAL ELEVATORS

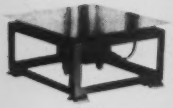


SHAFT SEALS

FLOW CONTROL VALVES

HOPPER LEVEL SWITCHES

solves many DESIGN problems



VIBRATORY PACKERS

SYNTRON designs, engineers and manufactures a complete line of equipment that can be used as components of other devices — producing a practical, proven answer to many design problems involving controlled vibratory motion (conveying, settling, elevating and agitating bulk materials), rotary shaft sealing (gas or liquid), automatic parts orientation and feeding, hopper level and flow control.

SYNTRON Equipment offers you more than 35 years of engineering experience in all types of industry.

If your current plans entail problems that can utilize such equipment it will pay you to call your nearest SYNTRON representative. — or write for a free SYNTRON Catalog

SYNTRON COMPANY

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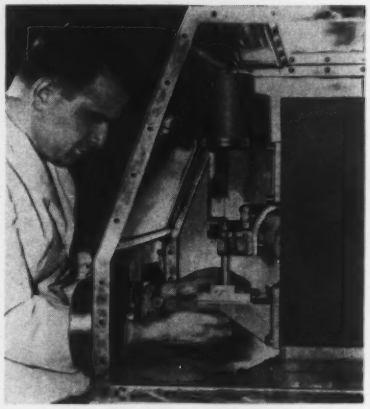

Welding Head

A precision welding device, compact enough to be installed in a standard "dry box" in which transistors and other electronic components are assembled, has been introdueed by Raytheon Co. Commercial Apparatus and Systems Div.

This new a-c or d-c welding head which measures 23½ in. high, 7½ in. wide, and 13 in. deep makes possible the use of lower welding currents and lower electrode pressures resulting in consistent welding performance even when welding microscopic parts. It is rated 2700 watt-sec (d-c) or 50 kva (a-c).

The head, which can be mounted horizontally or vertically, is adaptable to dial feed or in-line feed for automated production. **—K-24**

Production Tray

A special production tray for handling elicate electronic components is made by Spaulding Fibre Co., Materials Handling Equipment Div. of one-piece molded Spaulding vulcanized fibre. The tray is extremely lightweight and cannot tarnish metal-coated parts, even those that are silver-plated.

The tray is 13½ × 8¾ × 1½ in. and incorporates a unique stacking device on each end which allows safe, rigid stacking without damage to contents. A galvanized-steel top binding protects its edges. **—K-25**

Motors

The Lincoln Electric Co. line of 3-phase, squirrel-cage induction motors has been expanded to include sizes from ½ to 125 hp. "Multiguard" protection, a specially compounded thermosetting plastic will be used to encapsulate and impregnate the stator. The company states that this feature, pioneered by Lincoln in 1953, has made the motor a valuable asset to all types of industry where applications normally call for premium-priced total enclosure. **—K-26**

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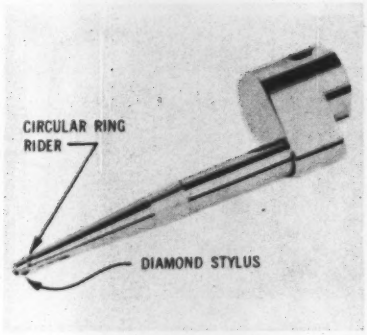


Adapters for Finish Measuring

Two small-bore adapters which extend the utility of the Surfindicator (unit for measuring surface finish) to very small IDs and other limited-access areas are now available from Brush Instruments Div., Clevite Corp.

Model BL-113 adapter, designed for use with Brush motor-drive Model BL-117, has a very small tip dimension which permits measurements on limited-access areas such as gear teeth, slots, and lands. It penetrates up to $^3/_{16}$ in. into an opening with an ID as small as $^1/_8$ in. It penetrates 2 in. into an opening of $^1/_4$ to $^3/_4$-in. ID and measures ODs down to 0.050 in. This accessory is designed for use in measuring to a maximum surface roughness of 250 microin.

A hand-held adapter, designated Model BL-134, is recommended for small bores, gear teeth, and slots where hand-held operation is required by location of the surface to be measured. It is particularly well suited for periodic checks at the machine during machining operations. —K-27

Vane-Type Hydraulic Pumps

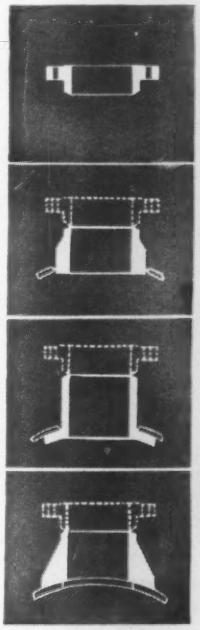
Double pumps have been added to the line of high performance vane-type hydraulic pumps produced by Vickers Inc. Div., Sperry Rand Corp. Previously released high performance single pumps are widely used on agricultural, construction, earthmoving, material handling, and other mobile equipment. The new double units extend the range of application by providing one power source for two separate hydraulic circuits or greater volume through combined delivery of both sections.

They are designed for normal operation at up to 2000 rpm and 2000 psi. The resulting increased capability means less cost per horsepower, greater work output, and space savings for the compact pump package. —K-28

Use a CLASSIFIED ADVERTISEMENT *for Quick Results*

LENAPE OFFERS A NEW CONCEPT IN PRESSURE VESSEL CONNECTIONS

Now—by combining a Lenape ASA bolt flange which is a short seamless welding neck and your choice of three seamless bodies, you get optimum reinforcement, design flexibility and economy.



SPECIAL ASA BOLT FLANGE

Simple, low cost attachment, with easier alignment and orientation. You can choose different materials for body and flange, as well as length with unmatched economy in lengths over 12″.

SEAMLESS CYLINDER EXTENSION

Superior to pipe or rolled plate. No seams. Built-in reinforcement. Choice of length and thickness.

TYPE C INTERNAL REINFORCING NOZZLE

Separate bolt flange makes more efficient internal reinforcement possible.

TYPE D EXTERNAL REINFORCING NOZZLE

External attachment with massive reinforcement.

All of these are available in 300 to 900 lb. ASA standards.

Full details and specifications are given in the new 96-page Lenape Catalog. Write for your copy.

LENAPE PRESSURE VESSEL CONNECTIONS

LENAPE HYDRAULIC PRESSING & FORGING CO.
DEPT. 114 WEST CHESTER, PA.
RED MAN PRODUCTS

Another
EXTENSIVE PIPING SYSTEM

Protected by
Williams-Hager *Silent* CHECK VALVES

Architect & Engineer: Holabird & Root, Chicago
General Contractor: Naugle-Leck, Inc., Minneapolis
Mechanical Contractor: Bjorkman Brothers Co., Minneapolis
Air Conditioning Contractor: Commercial Air Co., Minneapolis

The new building of the *First National Bank of Minneapolis* is another significant structure safe from water hammer damage and annoyance . . . through use of *Silent* Check Valves.

Write for Bulletins: No. 654 on Valves; No. 851 on Cause, Effect and Control of Water Hammer.

The Williams Gauge Co., Inc.
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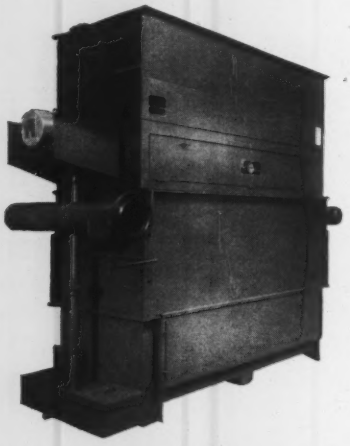
Our 74th Year • 1886-1960

How to get drier or cooler AIR or GASES
at low cost

NIAGARA *AERO* AFTER COOLER cools a compressed gas, or air, below the temperature of the surrounding atmosphere, thus preventing the condensation of moisture in your lines. The gas will contain only half of the moisture left in it by conventional methods. Even drier gas can be produced if you require it.

In working with controlled atmospheres of inert gases to prevent undesired reactions, this dryness of the gas at low cost is a great advantage. The cost of the Niagara method is low because it uses evaporative cooling, saving 95% of the cost of cooling water (and its piping and pumping). This direct saving of cost pays for the Niagara cooler in less than two years.



If you use compressed air to operate instruments or pneumatic equipment you will get better results by using the Niagara Aero After Cooler.

Write for Bulletin 130, or ask nearest Niagara Engineer if you have a problem involving the industrial use of air.

NIAGARA BLOWER COMPANY
Dept. ME-5, 405 Lexington Ave., New York 17, N. Y.
Niagara District Engineers in Principal Cities of U. S. and Canada

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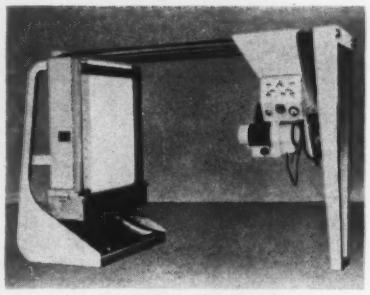

Projector-Printer

An electrophotographic projector-printer capable of virtually automatic reproduction engineering drawings up to 34 by 48 in. is available from Keuffel & Esser Co.

Named Kecofax, it is said to be the first projector printer capable of producing electrostatic prints of such magnitude.

It takes only 40 sec to produce a finished print. A pre-set regulator permits the equipment to make up to 19 prints automatically from a single negative.

The Kecofax projector-printer is 5 ft wide, 14 ft long and $7\frac{1}{2}$ ft high. It operates on an alternating current of 115 volts and 50 amp, and weighs 2100 lb. No venting is required. **—K-29**

Sub-Fractional D-C Motor

The RBD-25 precision subfractional d-c motor has been developed by Holtzer-Cabot Div., National Pneumatic Co., specifically for instruments, control apparatus, and timing devices. Mechanically interchangeable with the Holtzer-Cabot synchronous and induction motors of the same frame size, the motor is also available with gear reductions from 3/1 to 3600/1, basic motor speeds from 3600 to 900 rpm, and for voltage ratings from 115 to 24 volts d-c. The stock motor is shunt-wound, with 115 volts field excitation, and armature voltage may be changed from 0 to 115 volts for speed control. Output torque, for example, is 1.5 oz-in. at a speed of 1600 rpm and an armature voltage of 115 volts. **—K-30**

Silicon Power Rectifiers

A silicon power rectifier, Style 33, has been introduced by Syntron Co. A double-diffused diode, it is available with both standard and reverse polarity for immediate delivery.

The Style 33 is rated at 30 amp average at 25 C ambient on a $5 \times 5 \times 1/16$ in. copper heat sink. Peak inverse voltages range from 50 to 600 volts in 50 volt steps.

A typical forward dynamic resistance of 0.0035 ohms is achieved through conductivity modulation. **—K-31**

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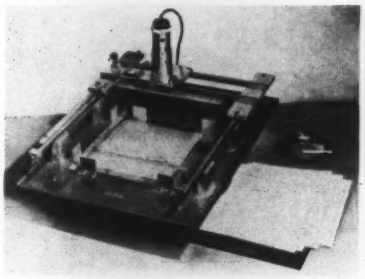


Information Handling

An "inverted" punched-card method is used by Jonker Business Machines in the company's Termatrex systems which will feature equipment claimed to be of greater speed, simpler operation, and a fraction of the cost of present information-retrieval machines of comparable performance.

The line is designed to handle small and medium-size information collections ranging in capacity from 10,000 to 200,000 items with the cost running from $200 to $2000. Equipment is also being developed to search millions of items in a matter of minutes.

A complete information-retrieval system consists of a "Termatrex" machine (about the size of an electric typewriter), sets of "keyword" cards (each card set having a basic capacity of 10,000 items of data) and a specially-designed card holder.

The system is searched by placing a number of keyword cards describing a question in the machines. Coinciding holes visible as light dots designate the document answering the question. **—K-32**

Packing Rings

Raybestos-Manhattan, Inc., Packing Div., No. 1250 Vee-Flex packing rings are made of Teflon-impregnated asbestos for high-temperature service at excessive pressures and speeds and require no lubrication.

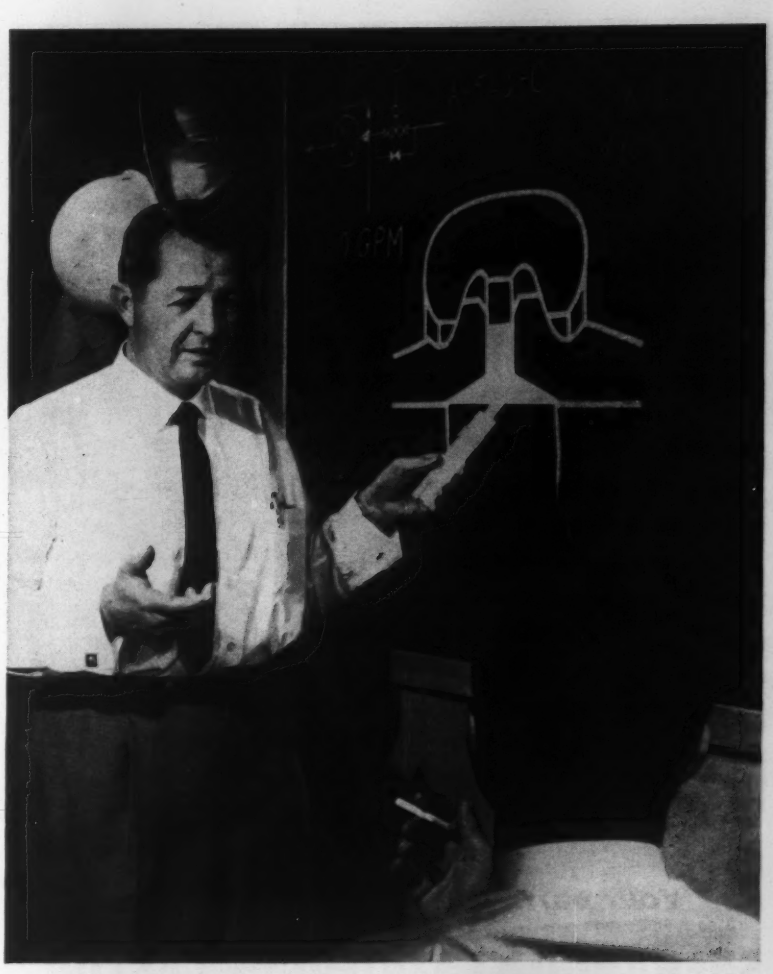
They have minimal thermal expansion, superior extrusion resistance, broad chemical resistance to 500 F and in some cases 650 F.

Hydraulic or gas pressure automatically expands the lip or circumference of rings on the pressure stroke, forming a tight seal against the stuffing wall or shaft without creating corresponding excessive friction and extrusion. **—K-33**

Pump Check Valve

The No. 205D pump check valve made by Universal Valve Co. was originally designed for gasoline-pump installations using Dresser Fittings in the suction line above ground.

The valve's main features include quick and easy installation, small space requirements, and no flow restrictions. **—K-34**



New GRAYLOC® Seal Eliminates Leaks

GRAYLOC is practical where leakage is a problem, regardless of high or low pressure, where savings in money, space, weight or time are desirable.

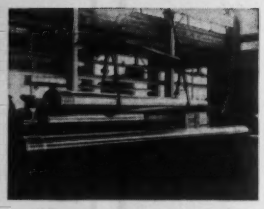
The GRAYLOC seal design, a new principle in pipe connection, is simple: tapered lips on either side of a rigid rib. The seal lip tapers slightly less than the mating hub, forming a line seal as the components touch. As the connection bolts are tightened, the lips deflect to form a positive, leak-proof surface seal. GRAYLOC Connections can be made and released repeatedly and still operate to pressure without seal ring replacement.

GRAYLOC works in most flange applications. If you are interested in more information about how GRAYLOC can solve your leakage problems and save you money, write for the new GRAYLOC CATALOG on your company letterhead. No charge, no obligation.

GRAYLOC SALES DIVISION

GRAY Tool Company

P. O. BOX 2291 HOUSTON 1, TEXAS REpublic 4-1641 04



Your parts last longer when they're

SHENANGO CENTRIFUGAL CASTINGS

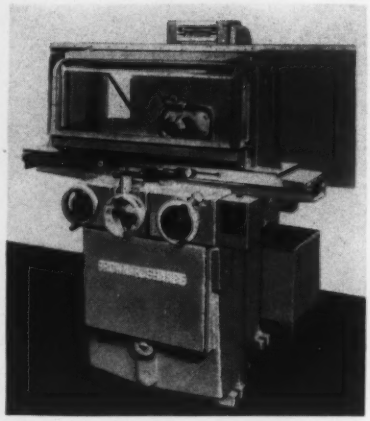
Your machine parts, ferrous or non-ferrous, are subject to stress, strain and friction, day after day, year after year . . . so specify Shenango . . . and see what a difference this makes!

Shenango's centrifugal casting process insures longer life because of finer, more uniform, *pressure-dense* grain to begin with . . . free of inclusions, porosity, blowholes and other weakening defects. Then, far less machining is needed and your part is stronger . . . to last and last *and last!*

Shenango's modern and fully-equipped shops will supply you with ferrous or non-ferrous symmetrical parts in virtually any shape or size . . . rough, semi-machined or precision-finished to your most exacting specifications. For full details, write: *Centrifugally Cast Products Division,* The Shenango Furnace Company, Dover, Ohio.

SHENANGO CENTRIFUGAL CASTINGS

COPPER, TIN, LEAD, ZINC BRONZES • ALUMINUM AND MANGANESE BRONZES
MONEL METAL • NI-RESIST • MEEHANITE METAL • ALLOY IRONS



Chlorinator

Fischer & Porter Company's Series 3400 line of chlorinators, features the unique Stack Regulator which permits significant advances in accuracy, safety, and flexibility. One basic model of the line provides manual or automatic control over capacity ranges from 0.1 to 2000 lb per day.

For complete protection against corrosion, the 3400 series are housed in rigid, single-unit fiberglass cabinets which require no painting or maintenance. All piping and working parts are likewise made of plastics or corrosion-resistant alloys, insuring immunity to chlorine attack.

Controlomatic models accept electric, pneumatic, or vacuum signals from any type of metering device, and accurately feed chlorine according to proportional, start-stop, program, multiple-rate, or residual control requirements. A unique Vis-I-Flow valve permits visual observation of the rate valve. **—K–35**

Air Hoist

A new air powered hoist by Joy Mfg. Co. offers a choice of several throttle and brake systems that make it adaptable for use in such areas as mine shafts for hoisting men and materials, car spotting at industrial plants and mines, submarine drill barges as anchor or spud hoist, barge spotting at docks, de-coking tank service.

The hoist has a lifting capacity ranging from 27,000 lb at 37 fpm to 3700 lb at 220 fpm.

A five cylinder, radial air motor (10, 17, or 23 hp) with integral gear case drives the large rope drum through a multiple roller chain. The rope drum has a capacity of 2300 ft of $^{3}/_{4}$ in. wire rope.

The entire assembly is mounted on a skid type base. According to the firm, this one-piece, welded steel base keeps all parts in permanent alignment. **—K–36**

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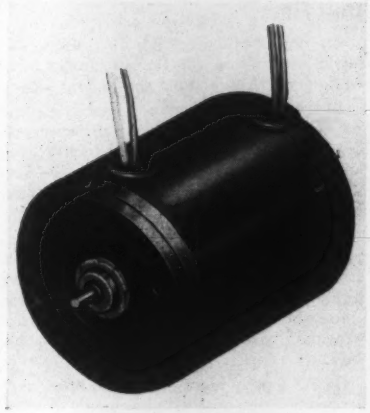

Subminiature Synchronous Motor

A 1-in-diam × $1^{13}/_{64}$-in. long, 400-cps subminiature synchronous motor, weighing only 1.7 oz, is made by Waltham Precision Instrument Co. Designated SM-1, it features jewel bearings which afford less friction loss than ball bearings, even at temperature extremes, for minimum inertia and maximum accuracy and reliability.

Operating at 115 volts with a maximum power input of $2^1/_2$ watts, the SM-1 has a speed of 3000 rpm and a power factor of 0.9. Rotation is reversible. The motor meets the military requirements for temperature, altitude, vibration, and shock as prescribed by MIL-E-5272B. —K–37

Torque-Transmission

What is described as a revolutionary torque-transmission device claimed to be the solution to many industrial design problems has been announced by Formsprag Co.

It features two opposing sets of full-complement sprags which completely block the possibility of reverse torque feedback to the input shaft. The many-purpose device operates both clockwise and counter-clockwise to drive, position, over-run, and backstop.

Named the Rev-Lok, the device is an evolution of the firm's clutch for over-running, backstopping and indexing applications. The company says the torque-transmission device delivers maximum torque for size and weight, and is designed for high over-running speeds.

The design is said to offer a wide range of applications. For instance, by mounting the outer race of the device in a fixed position, torque feedback is stopped by the wedging of sprags between the output member and the id of the outer race. This prevents torque feedback from reaching the input shaft, the firm explains. —K–38

Ventilating Fans
Roof Ventilators
...a galaxy of products to solve your air handling problems...
Industrial Fans
Centrifugal Unit Heaters
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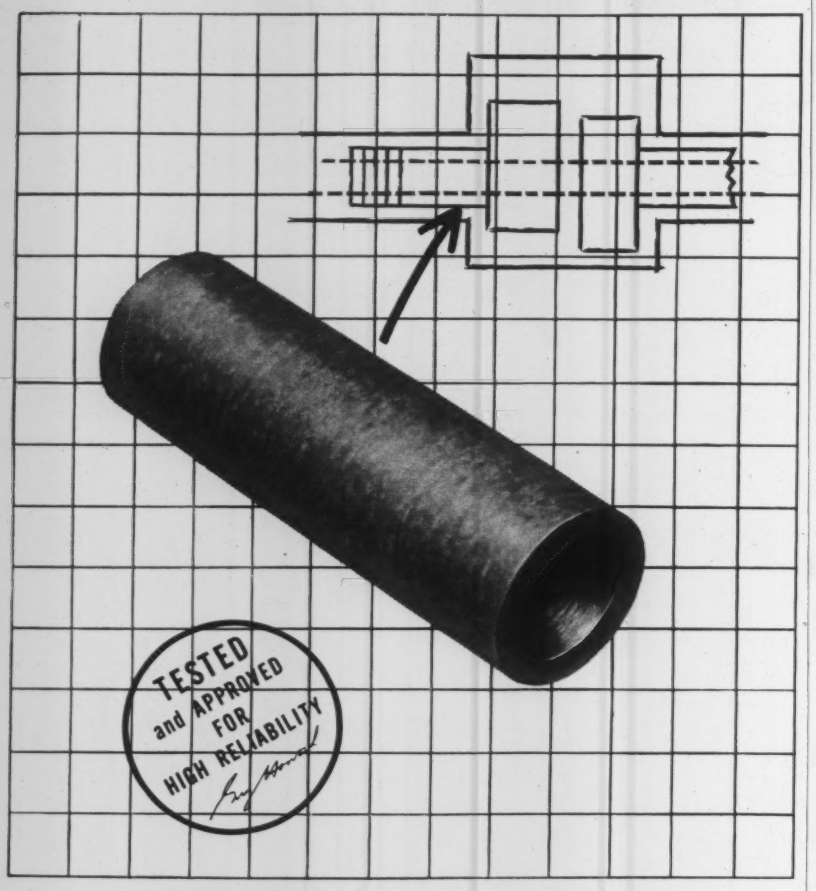
General Purpose Fans
nyb
THE NEW YORK BLOWER COMPANY
Sales offices: 3161 South Shields Avenue • Chicago 16

R/M CAPABILITY

produces reinforced Teflon bearings*

• to lower friction • to resist extrusion
• to resist corrosion • to eliminate contaminating lubricants



R/M reinforced Teflon bearings are giving excellent service in a wide variety of industries. In the chemical industry, their use has greatly extended the range of chemicals that can be handled by a single pump — and lengthened the life of shafts in acid pumps. In the textile and food industries, they have eliminated the need for lubricants and the resulting contamination of materials in process. And in almost every application, they have lowered replacement costs and maintenance requirements while reducing wear.

R/M reinforced Teflon bearings can be machined to very close tolerance. The high rate of thermal expansion and poor cold flow characteristics of pure "Teflon" have been greatly reduced with this reinforced material.

If you have a bearing application, particularly where corrosion and high temperatures present a problem, or where normal lubricants cannot be used, R/M reinforced "Teflon" bearings may be the answer. Send data on your application.

*Registered trademark for Du Pont fluorocarbon resins

RM PACKINGS
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N. J.
MECHANICAL PACKINGS AND GASKET MATERIALS

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Dust Filter

An improved-design RJ dust filter, the latest addition to the line of dust-control equipment manufactured by the Day Co.

A simplified method of maintaining the porosity of the filtering media is incorporated. The filter has also been improved by the addition of a reverse-air-pressure blower. Newly designed air-tight, quick-opening inspection doors have also been added.

The filter is available in five sizes in capacities ranging from 285 to 6400 cfm of air. Larger capacities are furnished by multiple groupings. Single units are supplied with round housings, while multiple units are furnished with square or rectangular housings.

The company reports that this filter, with its combination of felted filter media and new high velocity, counterflow air action, permits high filtering rates (air-to-cloth ratios of up to 20 to 1) while operating at efficiencies of 99.99+ per cent.

The RJ will filter light or heavy-grain-loaded airstreams and effectively filter extremely fine, coarse, abrasive, or non-abrasive dusts. It is designed to handle airstreams with temperatures as high as 300 F, and by using special alloys and filtering medias, in some cases, higher temperatures can be handled. **—K–39**

Nozzle-Bowl Separator

A new nozzle-bowl centrifuge for high-pressure and high-temperature operation, has been introduced by De Laval Separator Co. Designated the QX-312, this centrifuge may be used as a solids concentrator, liquid clarifier, or solid-particle classifier. It can handle up to 450 gpm at temperatures to 300 F and pressures to 125 psi.

The bowl covers meet standard pressure-vessel requirements, and necessary connections on the top and bottom cover are pressure-tight to allow continuous high-pressure operation. Top-cover connections are for feed, effluent discharge, and recirculation (if required). Bottom connections are for the nozzle discharge and vent for the nozzle discharge. Clarified effluent is discharged by means of a paring device which functions at a pressure differential up to 50 psi over the operating pressure. Solids discharged from nozzles flow by gravity from the vented sludge port.

A higher solids concentration can be obtained if a portion of the nozzle discharge drawn off by the process pump is recirculated through the machine. The degree of concentration can be varied by adjusting the amount of concentrate which is drawn from the system. Depending on volume requirements, material to be processed is fed to the system at about 5 to 25 psi above operating pressure. **—K–40**

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1	17-20	148	161	174	191	IFC
4	21	150	162	176BR	193	IBC
6	22, 23	151	165	177	195TL	OBC
7	24	152, 153	166L	178, 179	195MID-L	
8, 9	25	154	167R	180	195BL	
10	27	155	168	181	195TR	
11	28	156	169	182	195BR	
12	30	157	170	183	196	
13	31	158T	171T	187	205	
14	32, 33	158B	171B	188	207	
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K-1	K-12	K-23	K-34	K-45	K-56	K-68	K-79	K-90
K-2	K-13	K-24	K-35	K-46	K-57	K-69	K-80	K-91
K-3	K-14	K-25	K-36	K-47	K-58	K-70	K-81	K-92
K-4	K-15	K-26	K-37	K-48	K-60	K-71	K-82	K-93
K-5	K-16	K-27	K-38	K-49	K-61	K-72	K-83	K-94
K-6	K-17	K-28	K-39	K-50	K-62	K-73	K-84	K-95
K-7	K-18	K-29	K-40	K-51	K-63	K-74	K-85	K-96
K-8	K-19	K-30	K-41	K-52	K-64	K-75	K-86	K-97
K-9	K-20	K-31	K-42	K-53	K-65	K-76	K-87	K-98
K-10	K-21	K-32	K-43	K-54	K-66	K-77	K-88	
K-11	K-22	K-33	K-44	K-55	K-67	K-78	K-89	

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KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Laboratory Recorder

Bristol Co. is now offering a new laboratory model of its Dynamaster potentiometer recorder.

The firm says the recorder lends itself readily to measuring such variables as pressure, temperature, motion, flow, density, pH, and electric power.

Special input signal selection switches and span adjustments are designed to provide maximum flexibility. The four-position input selector switch provides for millivolt, volt, microampere, or milliampere input. The five-position span selector offers ranges 0–2, 0–5, 0–10, 0–25, and 0–50. An alternate span continuously adjustable from 0–2, to 0–50 is available.

An adjustable zero and push button standardization are standard. Automatic standardization is optional. —K–41

Control Valve

A new valve specially designed to control flow into a hydraulic motor has been announced by Fluid Regulators Corp.

Operating pressure for the 5-oz valve is 3000 psi. Normal flow is 2.2 gpm with a maximum allowable flow of 3.5 gpm and a limited flow of 0.5 gpm. Pressure drop across the valve is 20 psi (max) for a flow of 2.2 gpm.

The unit automatically limits flow when it reaches the maximum setting. After inlet pressure is reduced to 15 psi the valve automatically resets and permits normal flow.

Constructed of all stainless steel, with a bulkhead fitting on the outlet port, this speed limitor is designed to handle the usual hydraulic fluids and oronite. Specifications can be changed to meet users' specific requirements. —K–42

Reciprocating Compressor

Trane Co. has announced development of a hermetic model of its R-22 and R-12 reciprocating refrigeration compressor used for all types of air conditioning applications.

The compressor is fabricated in two cylinder sizes. Both have been built into four, five, six, and eight cylinder units. A smaller unit is also available with three cylinders. These nine compressors provide capacities from 10 to 100 tons.

The new units have a one-piece motor-compressor housing instead of a split casing with a bolted joint between the motor and compressor. The company says this prevents a variation in the gap between stator and rotor and assures proper motor operation. Internal double thermostatic motor temperature protection is provided. If the winding temperature rises for any reason, the motor stops. There is no time delay for overheating to be sensed by external heat detecting devices, the firm explains. —K–43

6 REASONS WHY JOHNSTON VERTICAL HIGH PRESSURE PUMPS HAVE BECOME SO POPULAR

Many uses: as suction boosters, in power plants, pipe lines, refineries, for bulk plant transfer, in municipal booster service.

1. SPACE SAVING—You get 3 times the capacity in ⅓ the space, with vertical Johnstons.
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3. LONG BEARING LIFE—In vertical Johnstons, thrust is taken up in the motor bearings, not in the pump, eliminating a frequent trouble source.
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Pressures over 1,000 psi.
Capacities to 12,000 gpm
Temperatures to 600°F.

For complete details talk to your nearest Johnston distributor or write direct to the factory for colorful "Type C Industrial Pump" bulletin.

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A DIVISION OF THE YOUNGSTOWN SHEET AND TUBE COMPANY

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FLEXIBLE COUPLINGS

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Future maintenance costs and shutdowns are eliminated when you install Thomas Flexible Couplings. These all-metal couplings are open for inspection while running.
They will protect your equipment and extend the life of your machines.
Properly installed and operated within rated conditions, Thomas Flexible Couplings should last a lifetime.

UNDER LOAD and MISALIGNMENT ONLY THOMAS FLEXIBLE COUPLINGS OFFER ALL THESE ADVANTAGES.

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THOMAS FLEXIBLE COUPLING CO.
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KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Color-Coated Steel

Color-coated steel, one of the fastest growing new building materials, is now being offered by Stran-Steel Corp., Div. of National Steel Corp., in nine new colors, selected to meet the demand of modern design trends. The new line of colors will be available on 26-gage panels, 36 in. wide and in any lengths desired. They are designed for use on walls and roofs, or with brick, wood, stone, or glass.

The factory-applied, baked-on color won't chip, peel, or fade. It is virtually a part of the steel and is said to stay on year after year.

The company also manufactures a complete line of pre-engineered steel buildings for farm, commerce, and industry, as well as architectural steel products, and steel products for the railroad industry. —K–44

Air Conditioners

A line of ruggedly designed, packaged, multizone air conditioners is available from American-Standard Industrial Div.

Available in nominal 25-ton, 30-ton, and 40-ton sizes, the nominal air-handling capacities are 10,200 cfm, 12,600 cfm and 17,100 cfm. The units are suitable for the heating-cooling requirements of large open areas or can serve several zones or rooms or any area where excessive heat load presents a special problem. —K–45

Indicating Transmitters

A Model 45 series line of pneumatic indicating transmitters for pressure, flow temperature, liquid level, differential pressure, and dew point has been introduced by Foxboro Co.

It features measuring elements specifically designed for each major process variable in the following ranges: (*a*) Pressure—0-10 in. water to 0-80,000 psi; (*b*) temperature—450 to +1000 F; (*c*) flow (differential pressure)—0-1 to 0-400 in. water; (*d*) liquid level—open vessels 0-10 in. water min, closed vessels 0-20 in. water minimum; (*e*) dew point—50 to +165 F. Output signal is 3-15 psi (3-27 psi optional). It operates on a 20-psi air supply.

The Model 45 has less than $\frac{1}{2}$ per cent error for ambient-temperature changes as great as 50 F, and over-all calibrated accuracy of the transmitter, including measurement and output signal, is guaranteed to be within $\pm\frac{1}{2}$ per cent.

Featuring link-and-lever calibration and a minimum of moving parts, the Model 45 is easy to adjust and maintain. Its large $6\frac{1}{8}$-in. scale and fluorescent pointer make for high-visibility local indication.

All instrument components are enclosed in a weatherproof steel case which has corrosion-resistant vinyl coating, gasketed door. Over-all case dimensions are $9\frac{1}{4} \times 11\frac{3}{8} \times 5$ in. A universal bracket is supplied for surface or 2-in. pipe mounting. —K–46

Product Recorder

A compact Model 6717 product recorder suited for watt or kilowatt recording and for multiple measurements such as weight times speed and flow times density has been announced by the Weston Instruments Div. Daystrom, Inc.

Two independent measuring systems are housed within a single case. Employing two electronic amplifiers, the instrument operates on a null-balance principle.

Two independent millivolt signals are connected to the individual inputs. The signals are multiplied and the product is recorded. Multiplying is accomplished through use of a retransmitting slidewire on one measuring circuit wired to the input of the second measuring circuit.

The range of the two completely separate measuring circuits can be rapidly changed, permitting use of replaceable range standards. Standard carriage speed across full scale is 2 sec. The 10-in. scale is easily read.

Chart speeds provide a range of 1 in. per hr to $\frac{1}{2}$ ipm and the speeds can be changed quickly. Higher speeds are available with a special motor. Alarm switches are available. —K–47

CANCER CAN BE CURED

More than one million Americans are living proof. Remember . . . your contributions helped save many of these lives. Your continuing contributions are needed to help discover new cures and, ultimately, the prevention of cancer itself • Remember, too, if you delay seeing your physician, you drastically cut your chances of cure. Annual checkups are the best way of detecting cancer in time • Guard your family! Fight cancer with a checkup and a check.

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BY

THE INSTITUTION OF MECHANICAL ENGINEERS

1 BIRDCAGE WALK, WESTMINSTER LONDON, S.W.1, ENG.

KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Automatic Loader

An automatic orientor-loader and locator developed by Gear-O-Mation Div., Michigan Tool Co., automatically feeds, positions, and rivets paint-can bail-holding ears, making it unnecessary for the operator to endanger his hands or fingers. The machine has previously been equipped only with automatic feed for the rivets. —K-48

Pressure Regulators

Two low-cost, compact pressure regulators have been announced by Watts Regulator Co. which are claimed to feature excellent flow capacity and accuracy.

Identical externally, the regulators differ internally, with Model 6 constructed of Underwriters Laboratory-approved materials for LPG and No. 7 of UL-approved materials for acetylene gas.

Constructed of die-cast zinc with internal parts of brass and diaphragm and disk of oil-resistant Buna-N, both are available in $^1/_4$-in. size only. They may be used as 2, 3, or 4-way regulators. —K-49

Replacement Motor

A permanent-split capacitor motor for replacement of motors in room air conditioners and furnace blowers has been announced by the General Electric Co. as a companion to the shaded-pole replacement motor announced last summer.

The new motor, with adjustable mounting adapter, permits substitution for almost any $5^1/_2$-in.-diam permanent-split capacitor motor by a repair or service man.

It is available in 6-pole models from $^1/_{15}$ through $^1/_6$ hp, 115 or 230 volts. The shaded-pole model is furnished in 4-pole models, $^1/_8$ through $^1/_4$ hp, 115 or 230 volts, or in 6-pole models form $^1/_{10}$ through $^1/_6$ hp, 115 or 230 volts. —K-50

Spark Arrestor

A vane-type spark arrestor, adaptable to mobile and stationary internal-combustion engines, has been introduced by the Air-Maze Corp. It employs a centrifugal-action principle to impart a spinning action to the air flow. This drives the heavy particles of hot carbon to the outside of the stream and into the spark trap. The straight flow action of the muffler places minimum back pressure on the engine and the trap can be easily cleaned. Any ordinary muffler can be installed with the arrestor without loss of operating efficiency.

Standard models may be ordered in four sizes to fit engines for 150 to 1200-cu-in. displacement. The manufacturer will provide bushings to permit installation on non-standard inlet pipes. —K-51

"THIS LUBRICANT WAS THE ANSWER TO OUR MAINTENANCE PROBLEM"

says the MOLYBDENUM CORP. of America

"We use a Hardinge conical ball-mill driven by a large gear and pinion in the processing of tungsten and molybdenum concentrates. Silicious dust from the grinding was absorbed by the soaplike lubricant we were using and formed a highly abrasive compound. Frequent replacements of gears and pinions were major maintenance expenditures. The change to LUBRIPLATE Lubricants was the solution to our problem . . . not a gear nor pinion replacement in four years."

William F. Allen, Works Manager

REGARDLESS OF THE SIZE AND TYPE OF YOUR MACHINERY, LUBRIPLATE GREASE AND FLUID TYPE LUBRICANTS WILL IMPROVE ITS OPERATION AND REDUCE MAINTENANCE COSTS.

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956

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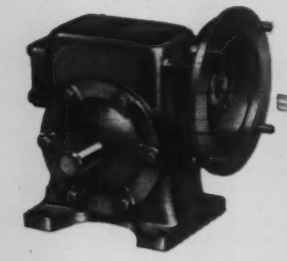
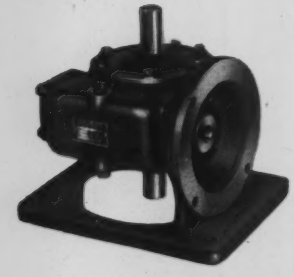
motorized
speed reducers

available from stock

Yes! 956 different combinations of Perfection Motorized Worm Gear Speed Reducers are available for immediate delivery, *from stock.* Ratios range from 5 to 1 to 60 to 1, in capacities from 1/6 H.P. to 5 H.P. Perfection "C" Flange Reducers may be ordered complete with motor or without motor, to be used with a motor *of your own choice.*





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PERFECTION GEAR COMPANY, HARVEY, ILLINOIS

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Piston Cups

Piston cups for hydraulic and pneumatic equipment, perfected by Raybestos-Manhattan, Inc., and made of Teflon-impregnated asbestos fabric are for applications requiring superior extrusion resistance, broad chemical resistance, temperature resistance to 500 F, and a constant low coefficient of friction without the aid of lubrication.

Designated No. 1550, they are precision molded and provide negligible friction at all pressures, dimensional uniformity, and maximum sealing efficiency.

Where common cups fail in tension at the base of the cup because of high friction at the sealing surface, these new cups, according to the company, remove the limiting factor making possible a new design concept. **—K-52**

Motor Couplings

Three features have been added to Link-Belt Co. line of MC geared flexible motor couplings: Corrosive-duty covers of polypropylene, extended size range to $2^1/_2$-in. bore, a spacer adapter which functions as a demountable, rigid extension of the motor shaft. Ask for Folder 2875. **—K-53**

Wall Deslagger

An air-powered wall deslagger that completes a normal cleaning cycle in less than 73 sec has been announced by Copes-Vulcan Div. Blaw-Knox Co. This high-speed operation is made possible by two separate air drives. One extends and retracts the nozzle almost instantly. The other rotates the nozzle slowly for thorough cleaning. Standard nozzle travel is 12 in. with 24-in. travel available.

Each deslagger in a sequence can operate in quick succession, so that the sequence can be repeated as often as needed for the desired results. The blowing medium may be air, saturated or superheated steam, or any combination of these media. **—K-54**

Portable Motor-Generator

A revolving field, "packaged" motor-generator set particularly useful for testing components has been produced at Kato Engineering Co. Static-exciter regulator maintains voltage at $^1/_2$ per cent of any preset voltage, from no load to full load. Frequency can be adjusted from 320 to 480 cps and can be maintained at ±4 cps of any preset frequency, after initial warm up.

The entire unit including meter panel and mag-amp static-exciter regulator is fully housed and is mounted on a portable, 4-wheel dolly. The set is rated at 3 kw, 3.3 kva, 115/200 volts, 3-phase, 320/480 cps. with static exciter, belt-driven by a 10-hp 220/440-volt 3-phase, 60-cycle, 1800-rpm synchronous motor. Comes completely ready for operation by simply hooking up input and output lines. Ask for Form 40875 for details. **—K-55**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Eliminating Nylon Slippage

Small interlocking or interfitting parts of molded nylon, which are difficult to hold in place during assembly because of their inherent and desirable slipperiness, can be made to adhere to each other temporarily with a drop of fluoroalcohol, according to du Pont de Nemours, E. I. & Co.

What the fluoroalcohol does, du Pont chemists explain, is to act as a very mild solvent to soften the adjoining surfaces of the slippery parts and, in effect, "weld" them together. The temporarily joined parts can be physically separated again by the light mechanical stress encountered in normal operation of the assembled unit. There is no damage to the plastic. **—K-56**

Flow-Control Valves

Rivett, Inc. has introduced a Series-8600 line of 3000-psi pressure-compensated flow-control hydraulic valves, used as ordinary "meter-in" "meter-out," or "bleed-off" types. Their use in a circuit means that excess oil is spilled over a relief valve, permitting the pump to operate at full horsepower at all times.

Advanced engineering features include: Knife-edge orifice which assures consistently uniform low flow; and minimizes change of flow with fluid temperature; special pressure balanced Teflon seals which require no drain connection; maximum flow capacities up to 125 gpm in $1^1/_2$-in. size are standard; valves are usable as two-port and three-port models; vernier knob has provision for safety-lock wiring; valves are available with return free-flow check.

Four basic sizes, determined by desired capacity are available: $^1/_4$-$^3/_8$-in. pipe tap has 6 gpm capacity; $^3/_8$-$^1/_2$-in. pipe tap has 16-gpm capacity; $^3/_4$-1-in. pipe tap has 30-gpm capacity; and $1^1/_4$-$1^1/_2$-in. pipe tap has 125-gpm capacity. **—K-57**

Cold-Work Die Steel

Latrobe Steel Co. has announced the development of a new abrasion-resistant, cold-work die steel for use in brick-mold liners, shot-blast liners, ceramic-tile liners, and for long-run blanking and forming dies which makes possible a 5 per cent reduction in price of its Press-Mor line of products.

Designated as BR-3 die steel, the Latrobe Steel development contains the highest percentages of carbon and vanadium in the cold-work die-steel field. A typical analysis shows 2.80 C, 5.25 Cr, and 4.50 V, resulting in hard abrasion-resisting vanadium carbides for increased wear. **—K-58**

For Consulting Engineers
Turn to Page 204

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produces the final design!

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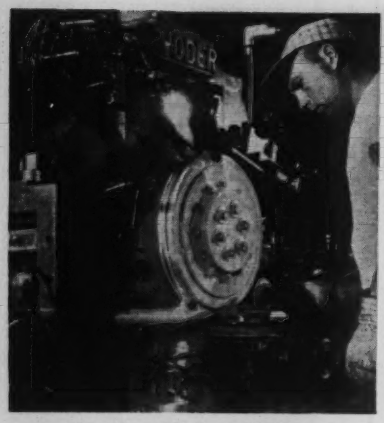

Yoder Tube Mills speed tailpipe production at AP Parts Corporation

The AP Parts Corporation (Toledo, Ohio), world's largest producer of replacement mufflers and tailpipes, uses 2 YODER Tube Mills to produce more than *300* ft. of 1¾", 1⅞" and 2" tubing per minute.

According to Mr. John Grindle, Plant Engineer, the two-man operated YODER Mills are vital to the production of the entire plant. "YODER Tube Mills earn their keep daily. They are easy to set up, maintain and operate ... the welds are clean and uniform. We depend on them for constant quality, high production and minimum downtime".

The YODER Tube Mills at AP Parts exemplify the production economies and dependability of all YODER-built equipment, whether it be Pipe and Tube Mills, Cold Roll-Forming Machinery or Slitting Equipment.

If your products require ferrous or non-ferrous pipe or tubing, from ¼" to 26" diameters, there is a YODER Mill designed to produce it economically, accurately and efficiently.

For complete information on YODER Pipe or Tube Mills ... write for the fully illustrated, 88 page YODER Tube Mill Book ... it is yours for the asking.

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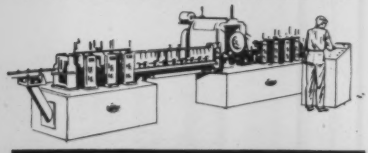

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PIPE AND TUBE MILLS
(ferrous or non-ferrous)

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Control Valves

A new 20000 series of single-seated control valves announced by Mason-Neilan Div., Worthington Corp., is engineered expressly to meet requirements of modern process and power-plant applications.

Features include high capacity, ability to handle high pressures and pressure drops and a wide selection of reduced-capacity trim.

Additional advantages for the series include a wide selection of materials for the design of body and plug to meet severe operating conditions, design of body and plug contours to make the valve suitable for viscous fluids and slurries, and a choice of either screwed, flanged, or welded ends.

It is now available in a range of sizes from ¾ to 10 in. with ratings in iron of class 125 or 250 ASA, and in steel from 150 to 2500-lb ASA. Standard spring-diaphragm actuators are sized according to body rating, and for applications beyond the scope of spring-diaphragm actuation, springless diaphragm, cylinder, or electric-drive actuators are available. —K–60

Fastener

A low cost plunger-type fastener which provides easy fastening and unfastening of panels doors, drawer fronts, and other sections is being introduced by the Hartwell Co.

Designated as Nylatch, the assembly is composed of two parts—a moulded grommet and a metal plunger, both of which remain captive in the removable panel or door.

To fasten, the assembly is inserted through a hole in the fixed section. Pressing the plunger forces the grommet fingers to expand on the inside of the hole to a greater diameter than the hole itself. Retraction of the plunger collapses the fingers, permitting the assembly to be withdrawn. —K–61

Load Controller

A load-controller made by Seneca Falls Machine Co. senses "real" load in kilowatts and is available for use with any machines that use a-c induction motors for driving power. The instrument will operate with single or three-phase systems at 110, 220, or 440. It senses both voltage and current and measures the phase angle between them.

A visible or audible alarm is actuated or the machine is shut down to prevent damage in case load becomes too great due to malfunction such as tool breakage on a machine tool. —K–62

Force Control Switch

W. C. Dillion & Co., has announced a special addition to its popular force control switch line. This new version is especially adapted to heavy duty service, or continuous outdoor application.

Developed for use on the clamshell bucket of cranes to activate a series of lights indicating pickup load weight, the new unit incorporates attachment eye and yoke integrally machined as part of the deflection beam.

In operation, the U-shaped beam moves outwardly. Switches contained in the housing at center are actuated at various pre-set load points by means of recessed adjustment screws located in the lower half of the beam.

Micro-switches are completely enclosed in a dust and moisture-proof case fitted with an aircraft type electric coupling. —K–63

BUSINESS NOTES

Research Center

Eaton Mfg. Co. will start construction soon of a new and expanded research center in Southfield, near Detroit, Mich., which will afford about 50 per cent more working area than the present facility in Detroit.

The modern $1¼-million structure will contain 28,751 sq ft of working area as compared with the present 18,694 sq ft.

Vacuum-Melting Furnace

The largest vacuum-melting furnace will be built at Allegheny Ludlum Steel Corp.'s Watervliet Wks. in New York State.

The furnace will be of the consumable-electrode vacuum-melting type pioneered by the company and its affiliate, Titanium Metals Corp. of America. It will produce ingots up to 50 in. in diam and at least twice the 20,000-lb weight of the vacuum-melted ingots now produced.

The furnace will be built by the Lectromelt Div., McGraw-Edison Co. and will bring to eleven the number of consumable-electrode furnaces in commercial production at the company.

HEART DISEASE #1 Enemy
GIVE ®
Defense #1 HEART FUND

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Polyester Film-Base Plant

A multimillion dollar building for the production of supertough polyester film base has been put into operation by the Eastman Kodak Co.

The new building contains high-heat process equipment to perform the necessary chemical reactions for making polyester resin, and continuous forming of polyester film base.

Two years in construction, the new Kodak plant contains 55,400 sq ft of floor space and special design features.

Forms New Division

Borg-Warner Corp. has formed a Controls Div. at Santa Ana, Calif., to take over the personnel, products, and existing facilities of the BJ Electronics plant of the company. The new division will have its own executive staff but will maintain close liaison with Weston Hydraulics, Ltd., another Borg-Warner subsidiary, prominent in the field of hydraulic and pneumatic power equipment for the aircraft and space industry.

LATEST CATALOGS

Roller Bearings

A 68-page size and capacity handbook issued by McGill Mfg. Co. contains data on sizes, capacities, mounting details, and interchangeability of selected series of the company's Camrol, Multirol, Guiderol, and Cagerol roller bearings, and band-saw guide wheels. —K–64

Heating Element

The "wire-mesh" heating element available from Electrofilm, Inc., is described in a 16-page catalog which gives complete technical data, physical properties and thermal characteristics of the varied components of this type now being used in the aircraft, missile, and space-age fields to provide local heating. —K–65

Rotary Air Products

Application ideas for air motors, air compressors, and vacuum pumps made by Gast Mfg. Corp. are contained in a recent 12-page bulletin. There are over 40 specific suggestions for process use.

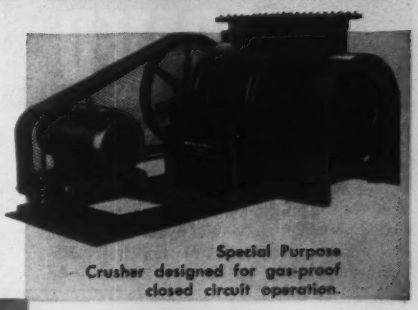
Another company publication is an eight-page catalog of the equipment line itself, in which a rotor and four sliding vanes are the only moving parts. —K–66

CUSTOM DESIGNED SPECIAL PURPOSE

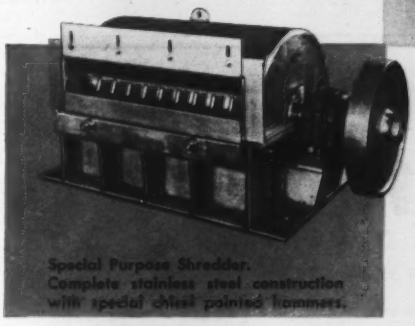
CRUSHERS

For over 50 years American Pulverizer Company has manufactured reduction equipment exclusively. Hundreds of products are reduced in American Crushers, Shredders or Hammermills.

Whatever your product, American can furnish standard or custom-designed equipment to handle your reduction problem.



Special Purpose Crusher designed for gas-proof closed circuit operation.



Special Purpose Shredder. Complete stainless steel construction with special chisel pointed hammers.

FREE TESTING SERVICE

Send a 50 lb. sample of your product to us, F.O.B. St. Louis. American's engineers will run tests and recommend the proper reduction equipment. No obligations, of course.

Write for Bulletin "WC & WS" Crushers, Shredders & Hammermills.

American PULVERIZER COMPANY
ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS
1541 MACKLIND AVE. ST. LOUIS 10, MISSOURI

Specify an Adams Aftercooler for Maximum Compressed Air Efficiency

When you design your compressed air system, be sure all of the components are specifically engineered to do their job most effectively. An Adams Aftercooler and Cyclone Separator is specifically engineered to achieve maximum operating efficiency — backed by more than 25 years experience.

Adams design offers you all the extras to insure peak performance throughout its operating range. 10° cooling is "standard" to assure optimum water and oil removal required for most applications. For more complete removal, 2° cooling is also available.

The exclusive Adams Cyclone Separator design assures you complete removal of the condensed liquid at any through-put up to design capacity, assuring you maximum separation for your cooling water dollar . . . and cleaner, drier air.

Many mechanical design extras are standard with Adams. The floating tube sheet is machined after the tubes are rolled — for longer packing life. Packing gland strain is eliminated by externally supporting the floating tube sheet. Mass production makes these "service saving" features available at no premium in price. Thus, trouble free air is yours at minimum equipment cost.

Why not realize all the advantages of a unit specifically designed to do its job best. Write today for the complete story — ask for Bulletin 714.

R. P. ADAMS CO., INC.
204 East Park Drive, Buffalo 17, New York

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Coated Abrasives

A Coated Abrasives Selector Chart for Textile Mills has been prepared by Carborundum Co. Recommendations are made for coated abrasives to be used in the card room, the carpenter shop, machine shop, mill maintenance and safety, and the roller shop.—K–67

Spring Materials

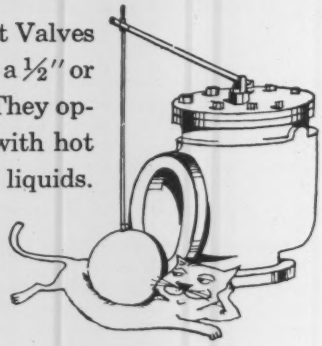
An eight-page handbook on spring materials published by Riverside-Alloy Metal Div., H. K. Porter Co. discusses copper-base, nickel-base, and stainless-steel alloys suitable for springs. —K–68

LIQUID LEVEL CONTROL

G-A *Cushioned* Float Valve

Sensitive Golden-Anderson Float Valves automatically hold water level to a ½" or 1" variation in tanks, bins, etc. They operate at high or low pressure—with hot or cold water—and most other liquids.

Bulletin W-5A has all the facts.



GOLDEN ANDERSON Valve Specialty Company

1223 RIDGE AVENUE, PITTSBURGH 33, PA.

Designers and Manufacturers of VALVES FOR AUTOMATION

Iron Castings

The engineering facilities and services used in the production of castings from a wide range of iron alloys are presented in a 12-page brochure issued by Hamilton Foundry Inc. which contains a useful comparative-properties chart and description of the standard, high-nickel and ductile irons produced. —K–69

Lifting Magnets

Stearns Magnetic Products "Pow-R-Light" line of lifting magnets designed specifically for scrap handling is described in Bulletin No. 3201, recently issued.

The lightweight, heavy-duty magnets are available in 36, 39, 45, 55, and 66-in. diam. They feature lighter aluminum field coils and all-welded, water-tight construction for longer maintenance-free life under the severe conditions of scrap-handling service.—K–70

Miniature Gages

Miniature vertical-type gages with 5-in. scales for measuring and indicating draft, pressure, differential pressure, temperature, and pneumatic signals are described in Bulletin 59-1 issued by Republic Flow Meters Co., subsidiary of Rockwell Mfg. Co. The bulletin shows such gage features as scales and ranges available, mounting dimensions, and lighting details. —K–71

Gears

"An Advanced Concept in Modern Gears," is offered by the Philadelphia Gear Corp. The 12-page booklet describes the advantages in using hardened and precision-ground gears in radar drive units, rotary-wing aircraft, high-speed gas-turbine drives, dredge-cutter drives, marine propulsion, and other applications. —K–72

High-Temperature Alloy

"W-545 Vacuum-Melted High-Temperature Alloy," a 12-page technical-data booklet available from the Westinghouse Electric Corp. has photomicrographs of the structures of the material and data on metallurgical characteristics, physical, mechanical, creep and creep-rupture properties, availability, and material processing.

W-545 is an austenitic precipitation-hardened iron-base alloy containing Ni, Cr and relatively small portions of Mo, Ti, B, Si, and Mn developed primarily for improved gas-turbine disks. It has exceptionally high creep strength combined with good ductility and excellent oxidation in the 1000 to 1350-F range. Ask for Technical Data 52-263. —K–73

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Fork Truck

A 5000-lb capacity battery-powered fork truck, the Carloader 5024, is described in a four-page brochure issued by Industrial Truck Div., Clark Equipment Co.

Engineering and dimensional specifications, and standard features such as carbon pile resistor, non-plugging controls, and roller-type upright are described. —K-74

Gage Illuminators

A new two-page data sheet No. 375, issued by Jerguson Gage & Valve Co., covers the features and sizes of UL and CSA-approved explosion-proof illuminators, designed to give a bright, evenly diffused light over the entire length of the gage glass and easily relamped. —K-75

Boring Mills

A 42-page bulletin on the complete line of Farrel-Betts vertical boring mills, ranging in capacities from a swing of 7 ft to 42 ft and larger gives complete specifications of each mill and a description of the optional features available. Issued by Consolidated Machine Tool Div., Farrel-Birmingham Co. —K-76

Flexible Couplings

T. B. Wood's Sons Co. Bulletin No. 5103 (revised) covers the complete line of Sure-Flex flexible couplings including the new "Junior" couplings with flanges of zinc alloy AG40A and the large-size brushes . . . couplings fitted with Sure-Grip interchangeable, QD-type tapered bushings. New engineering data is also given in the 10-page booklet on spacer couplings with drop-center sleeves and on the use of Sure-Flex couplings with a floating shaft to connect two shafts that cannot be brought close enough together to be connected by a single coupling. —K-77

Chain and Sprockets

The most extensive line of roller chain and Taper-Lock sprockets ever offered by Dodge Mfg. Corp., is presented in a new 56-page bulletin, A691.

It includes single strand, double strand, single strand heavy series, double pitch drive, double pitch conveyer, double pitch conveyer with large rollers, and standard attachments.

Photographs and diagrams show construction details and advantages of Taper-Lock sprockets for easy and secure mounting on shafts.

Complete with selection data and list prices, the bulletin includes information on installation of roller chain drives, calculation of center distances, horsepower ratings, conveyer engineering, and instructions for lubrication and maintenance. —K-78

Pumps

A line of Vari-Flow pumps and proportioning units which permit quick and accurate control of liquid flow are described in Bulletin 600, issued by Blackmer Pump Co. They are available in four basic types to fit a wide range of service. —K-79

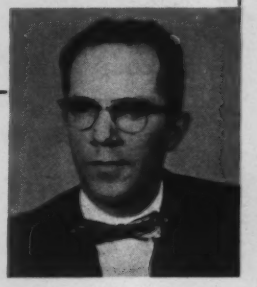
Rotary Bushings

A two-page brochure issued by Standard Rotary Bushing Co. describes a new line of rotary bushings which includes bushings of conventional design and those with a newly patented direct drive. —K-80

"FASTAX EXPOSES CAVITATION DAMAGE of METALS"

writes W. C. LEITH

of DOMINION ENGINEERING COMPANY, LTD.



W. C. Leith winner of the Engineering Institute of Canada (1959) Duggan Prize and Medal for his paper "Cavitation Damage of Metals."

"A FASTAX camera has been used in our cavitation research program. The model WF-4 at 8,000 frames per second identified the bubble pattern on a test button subjected to accelerated cavitation in distilled water." (Films show cavitation bubble pattern similar to damage pattern).

"The FASTAX camera, providing a time magnification factor of 500 for this work, contributed substantially to the exploration of this somewhat obscure subject."

W. C. Leith

Here's Proof:

Bubble pattern on vibrating test button.

Accelerated cavitation apparatus with FASTAX camera ready to record results.

LET FASTAX HIGH SPEED PHOTOGRAPHY HELP SOLVE YOUR ENGINEERING ANALYSIS PROBLEMS

WRITE for more detailed information and literature.

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OPTICAL COMPANY • ROCHESTER 21, N. Y.

MERCOID® CONTROLS

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Controls for–

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- MERCURY SWITCHES
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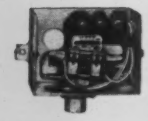


TYPE AP-153

New SP-DT low pressure (instrument air) control. Small in size, light in weight. Provides any of following operations: SP cut-in high; SP cut-in low; or SP-DT operation. Two operating ranges 1 to 20 and 1 to 30 psig. External adjustments, visible dial and visible circuit position. See catalog No. 860

TYPE PG

New low pressure diaphragm control for gases or air. Can be used three ways; for pressure, negative (vac.) pressure or differential pressure. External adjustments, visible dial and visible on-off circuit position. Two operating ranges, 1.0" to 30.0" and 1/2 to 5 psig. See catalog No. 860

ASK FOR CATALOG NO. 860

THE MERCOID CORPORATION
4211 Belmont Ave., Chicago 41, Ill.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Proximity Meter

A comprehensive new technical-applications manual on a capacitance-operated proximity meter, is available from Robertshaw-Fulton Controls Co. The booklet, TM-951-2, contains a complete description of the device, circuit and dimensional information, and numerous application specifics including layout and configuration details.

Applications include use as a micrometer without application of pressure and without physical connection to the work, gaging of concentricity without physical contact, as a surface-finish gage, as a strain gage, and for measurement of surface finish internally. Other uses are for measuring vibration, measuring breaking strain, as a thickness gage, as a pressure gage, and to measure moisture content. **—K–81**

Graphite

The U.S. Graphite Co. Div., Wickes Corp. has released an eight-page booklet on "Graphite, Its Properties and Uses," which explains the three types of graphite. It also outlines in detail the principal properties, characteristics, and applications of natural amorphous crypto-crystalline graphite, an easily pulverized nontoxic material which has gained great value as metallurgical carbon, as a super refractory, and as an industrial lubricant and lends itself readily to a host of new applications. **—K–82**

Flame-Failure Protection

Nine custom-engineered control centers and systems for combustion safeguard and automation are described in a 20-page booklet issued by Webster Engineering Div. of Midland-Ross Corp. Although designed for Webster burners, they are adaptable to other makes. The starting sequences and design data are tabulated for each system. These range up to a three-boiler system with a combined steam flow of about 200,000 lb per hr. **—K–83**

Gear-Indexing Mechanisms

Ferguson Machine Corp.'s Catalog No. 160 is a 40-page compilation of standard roller-gear drive-indexing mechanisms, high-speed precision index tables, in-line transfer machines and allied equipment. Complete load ratings, dimensions, and installation data are presented in table form. New features include: A double-enveloping worm-gear-type speed reducer which mounts directly to the cam shaft of an index table; a "direct" power unit with motor, clutch-brake, and reducer which may also be mounted directly to the index-table cam shaft and a pivot-mounted power-transmission system which swings out from a machine base for maximum accessibility. **—K–84**

Magnetic Starters

The Clark Controller Co.'s eight-page illustrated bulletin, PL 12-8-160, gives engineering data on Type-CY starters. Available in a full range of sizes from 0 through 4, the starters feature sturdy construction, simplicity of design, and fast, easy maintenance. The Clark arc-quenching principle, used on the size 2, 3, and 4 starters, which provides greater contact life under heavy current loads and severe arcing conditions, is fully described and diagrammed. The enclosures, forms, and combinations of CY starters for every industrial requirement are shown. **—K–85**

Flow Controls

A six-page brochure is available on the L-P-D- Mesurflo line of automatic flow controls made by Hays Mfg. Co. A wide variety of flow rates are available from $^{2}/_{10}$ to 50 gpm. The device which will automatically compensate for pressure surge and pressure drop to maintain one constant flow rate, is available in six pipe sizes. **—K–86**

Socket Screws

A technical reference on industrial socket screws has been issued by Standard Pressed Steel Co. The 82-page publication covers more than 2800 items including socket-head cap screws, set screws, shoulder screws, button-head screws, pressure plugs, and socket-screw keys. Additional product lines reviewed are Unbrako square-head set screws and dowel pins. **—K–87**

Water Treatment

The chemical treatment of industrial cooling water is the topic of a four-page brochure issued by Western Chemical Co. which outlines some of the aspects of cooling-water problems and the company preparations available for their solution.

Another publication by the same company gives more complete information on one of these preparations, Coravol, a process for the application of organic amines to steam systems for corrosion prevention. **—K–88**

Control Valves

Automatic Split-Body Control Valves and Accessories" is the title of a catalog offered by the Hammel-Dahl Div., General Controls Co.

The 20-page publication includes data on the new S and Y style split-body valves, each with its own angle variation. For the first time, conventional split-body valves, having actuators perpendicular to the pipe line, are offered along with Y-type having actuators at a 45-deg angle to the pipe line. **—K–89**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Pendent Switches

An eight-page illustrated bulletin describes in detail nine new pendent switches made by Joy Mfg. Co. for electric-hoist control.

Safety and minimum maintenance are the principal features of these switches, which are encased in corrosion-proof, shock-resistant, water-tight Hycar synthetic rubber. Switches are available with two, four, or six buttons, with one and two-speed control, and in a choice of snap-in aluminum legends. Information is also provided on the Joy line of toggle and other types of molded-to-cable switches. **—K–90**

Shaft Seal

Precision Bellows Rotary Seals are described in Hydrodyne Corp.'s four-page bulletin on this unique shaft seal. Types, sizes, special alloys available, and a typical installation are described.

Used in rockets, missiles and high-performance aircraft at −400 to +1200 F, with pressures from absolute zero to 500 psi for formed bellows and 10,000 for machined bellows, the stock sizes run from $^3/_4$ to $2^1/_2$-in. and others are available on special order. **—K–91**

Pressure Gage

A concise four-page folder, Bulletin DH-333, describing the complete line of Type 110 Gearcoid gages, pressure instruments designed for a wide range of industrial applications, has been released by the Helicoid Gage Div., American Chain & Cable Co.

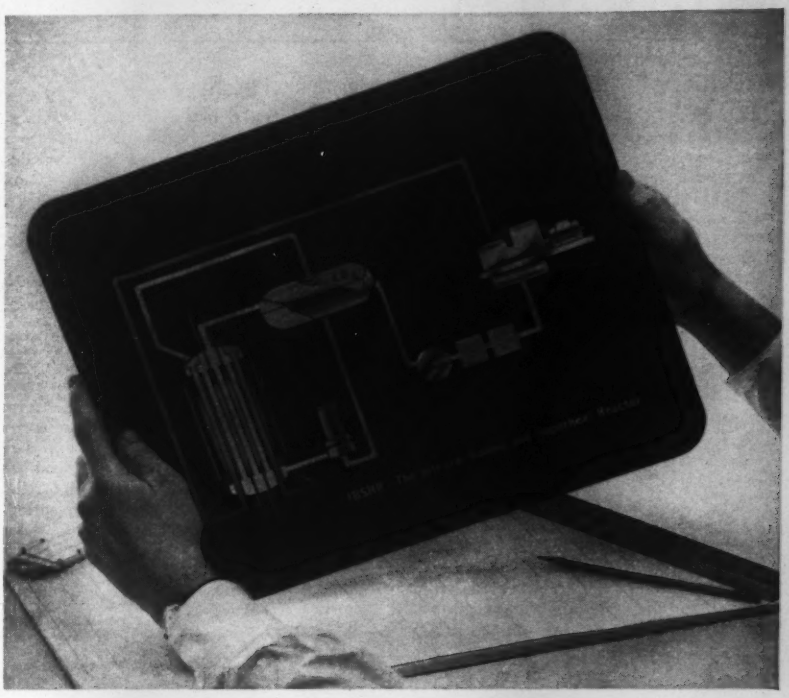
These heavy-duty, multi-purpose, general-utility gages which feature a geared movement are recommended for oil, air, water, steam, gas, or any other media not corrosive to brass or bronze. They are available for immediate shipment in 20 different standard ranges. **—K–92**

Gas Engine

Model TPV, a 2-cycle, V-type, turbocharged gas engine designed by Clark Bros. Co. as a compact, high-horsepower driver for centrifugal pipeline compressors, generators, and liquid pumps, is illustrated in Bulletin 176.

Joining 2-cycle simplicity and dependability with V-engine compactness, the TPV is said to have minimum number of wearing parts, maximum horsepower-to-space ratio, conservative 110 bmep, and lowest fuel consumption ever achieved in a 2-cycle engine. Other advantages include wide safe operating range, ample reserve capacity for temporary overloads and an unusually low maintenance factor. Rugged construction incorporates a rigid, one-piece cylinder block, heavily ribbed crankcase, huge computer designed crankshaft, removable power cylinder liners, and a completely automatic, jet-air-started turbocharger. Models are built with 10, 12, and 16 power cylinders, rated at 4000, 4800, and 6400 bhp respectively. **—K–93**

NEW PROFESSIONAL GROWTH OPPORTUNITIES for PHYSICISTS, SCIENTISTS, ENGINEERS, (Metallurgical, Chem., Mech.)



IBSHR—The Integral Boiling and Superheat Reactor, in which water is boiled and superheated within the same reactor core, is one of the advanced concepts under study. To realize the advantages of this concept, challenging problems in reactor control, fuel element design and frabrication, and fluid mechanics will require solution.

Scientist-Engineer—To plan, set up, perform and analyze critical experiments on light and heavy water reactors. Must have M.A. or M.S. or equivalent experience in nuclear physics or engineering.

Scientist-Engineer—To perform reactor physics design calculation and to solve advanced problems in reactor statics. M.S. degree in physics or engineering. Experience desirable, but not necessary.

Engineers—Design and development of reactor core components such as fuel assemblies, control rods, core plates and barrels. M.S.M.E. degree or equivalent experience in mechanical design systems and components.

Engineers—Materials development for fuel element prototypes including fabrication and testing of aluminum, zirconium and stainless steel alloys. B.S. degree in Metallurgy and preferably nuclear experience.

Scientists and Engineers who want to make the transition to the expanding field of commercial atomic power with a company that is a leader in the field, write to: Mr. C. S. Southard, Westinghouse Atomic Power Division, P.O. Box 355, Dept. W-96, Pittsburgh 30, Pa.

Westinghouse
ATOMIC POWER DIVISION
FIRST IN ATOMIC POWER

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Steel Tubing

Both seamless and electric-welded steel tubing are described in the 8-page catalog, CS-60, offered by Ohio Seamless Tube Div., Copperweld Steel Co. Carbon and alloy-steel grades of seamless tubing are covered in mechanical, pressure, aircraft mechanical, and airframe categories. Carbon-steel grades of electric welded steel tubing are reviewed in mechanical and pressure categories.—**K–94**

Motors and Relays

Typical specifications and illustrations on a complete line of Barber-Colman Co. a-c and d-c fractional horsepower motors, tachometer generators, and ultrasensitive relays are given in a new four-page folder, F-9765.

Rated horsepower, dimensions, special features and typical applications of the motors and relays are listed. Motors are available in a variety of voltage ranges, styles, and specifications to meet airborne, commercial, and industrial applications.—**K–95**

Instrument Bearings

A design and purchasing manual on miniature and instrument bearings available from New Hampshire Ball Bearings, Inc., includes the company's engineering bulletins on lubricants, cleaning assembled bearings, meaning of ABEC tolerances, and other related topics. There is also material on selection and application as well as tabulated bearing data in its 142 pages. —**K–96**

Relief Valves

A bulletin available from Cochrane Corp. describes the complete line of the company's multiport relief valves for automatic safe relief of overpressure in steam, air, and gas systems up to 250 psig. Multiport relief valves have from 3 to 21 internal spring-loaded valve disks which are adjustable for specific line pressures. Overpressure forces these valves open gradually. This action produces both automatic safety relief and pressure regulation. —**K–97**

High-Voltage Switch Cubicles

Allis-Chalmers Mfg. Co. describes high-voltage Type Q switch cubicles in new literature, No. 3287.

The cubicles are supplied to customer's specifications to house a frame-mounted, manually-operated, Type LBS load-break switch which incorporates the function of a disconnecting switch and a circuit interrupter for interrupting transformer magnetizing and load currents. The switches are available in the cubicles for load-break or isolator duty.

Information is included on operation and maintenance of the load-break switch which is suitable for transformer primary switching in unit substations, for service-entrance switching, for throw-over from preferred to emergency circuits, for loop-circuit sectionalizing, and for isolating plant feeders.

When combined with power fuses, the switch also provides substation protection and switching, sectionalizing and protection of branch distributing feeders, and short-circuit protection on primaries of industrial substations. —**K–98**

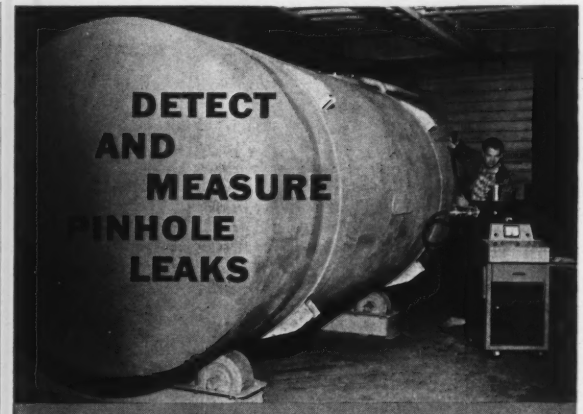
MECHANICAL ENGINEER

ADVANCE DEVELOPMENT OF SEMICONDUCTOR DEVICES

MS or BS with a background in electrical components field to handle a number of technical responsibilities relating to new transistor housings and other mechanical elements of transistor design.

WRITE: M. D. Chilcote, Div. ME-5
Semiconductor Products Dept.
Electronics Park,
Syracuse, New York

GENERAL ELECTRIC

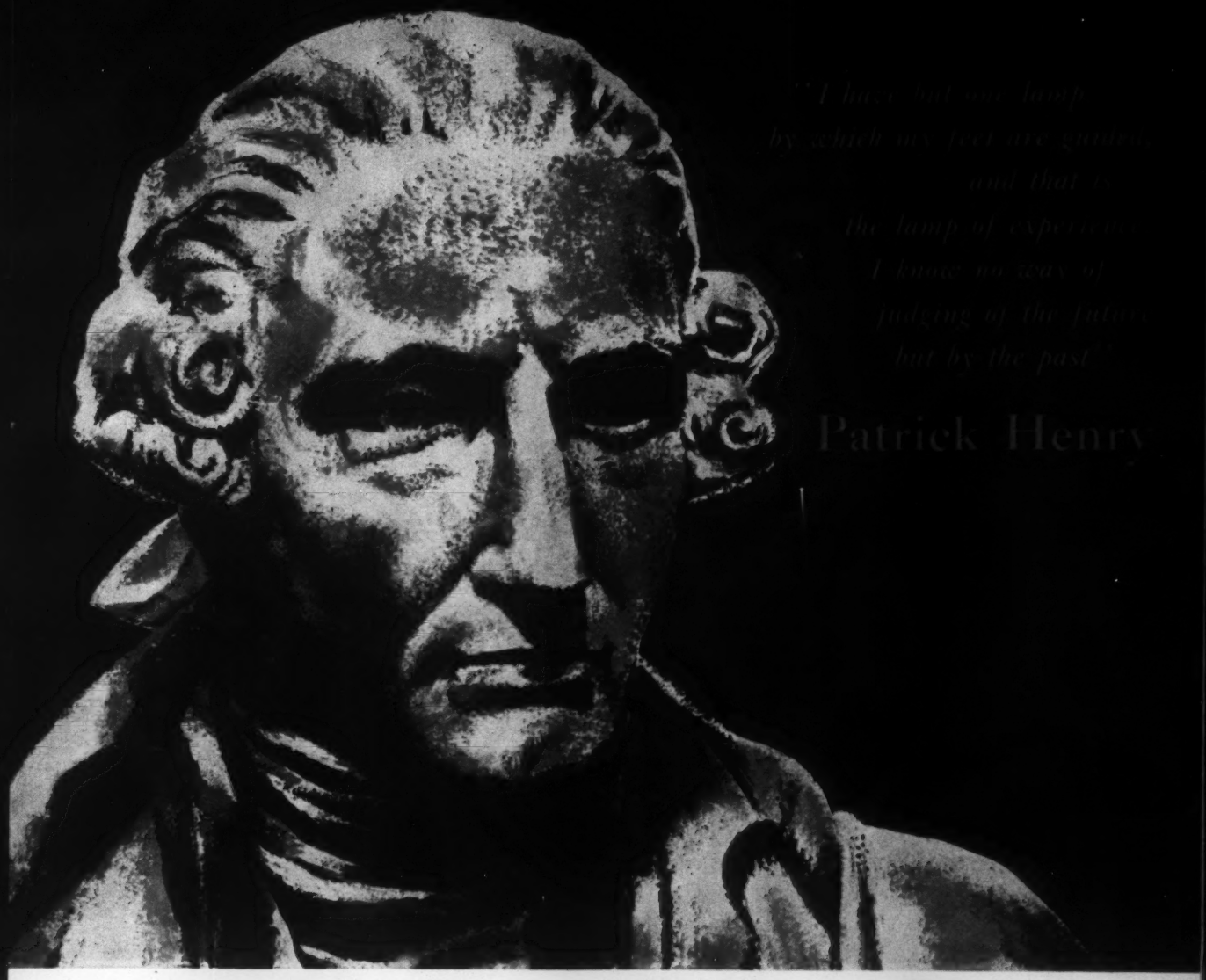


CEC's Helium/Mass Spectrometer Leak Detectors can help you locate and measure any leak you will need to find—certify Mil-Spec leak tightness—locate and measure flow rate of leaks so small that one cc of air at 14 lb. pressure would take more than 60 years to escape. These Leak Detectors are backed by CEC's 25 years of mass spectrometer experience. Two types are available—Mobile 24-110A, and Portable 24-210A, shown with mobile workstand. Call your nearest CEC sales and service office or write for Bulletins CEC 1838-X1 and 1830-X1.

Analytical and Control Division CEC

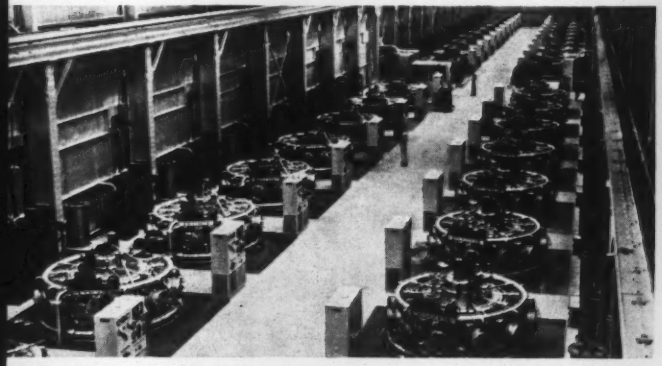
CONSOLIDATED ELECTRODYNAMICS

360 Sierra Madre Villa, Pasadena, California


"I have but one lamp
by which my feet are guided
and that is
the lamp of experience
I know no ways of
judging of the future
but by the past."
Patrick Henry

from experience . . .

Engines for the Power Needs of Today...and Tomorrow



Part of the 242 Nordberg gas burning radial engines installed at the ALCOA aluminum reduction plant at Point Comfort, Texas, totaling almost half a million horsepower . . . the world's largest internal combustion engine power station.

True today as it was in the early 1900's, Nordberg continually looks toward the future needs of the power industry . . . while solving the present power requirements efficiently and economically.

. This philosophy characterizes Nordberg . . . a leader in the early development of internal combustion engines. With the "lamp of experience" as an important guide, Nordberg continues to pioneer . . . to design and build even more efficient prime movers that will reliably provide the power required in the decades of tremendous growth ahead . . . and to accomplish this task at the lowest possible cost.

NORDBERG MANUFACTURING COMPANY • Milwaukee 1, Wisconsin

ATLANTA • CLEVELAND • DALLAS • DULUTH • HOUSTON • KANSAS CITY • MINNEAPOLIS • NEW ORLEANS • NEW YORK • ST. LOUIS
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NORDBERG MACHINERY

©1960, N. M. CO.

P-360

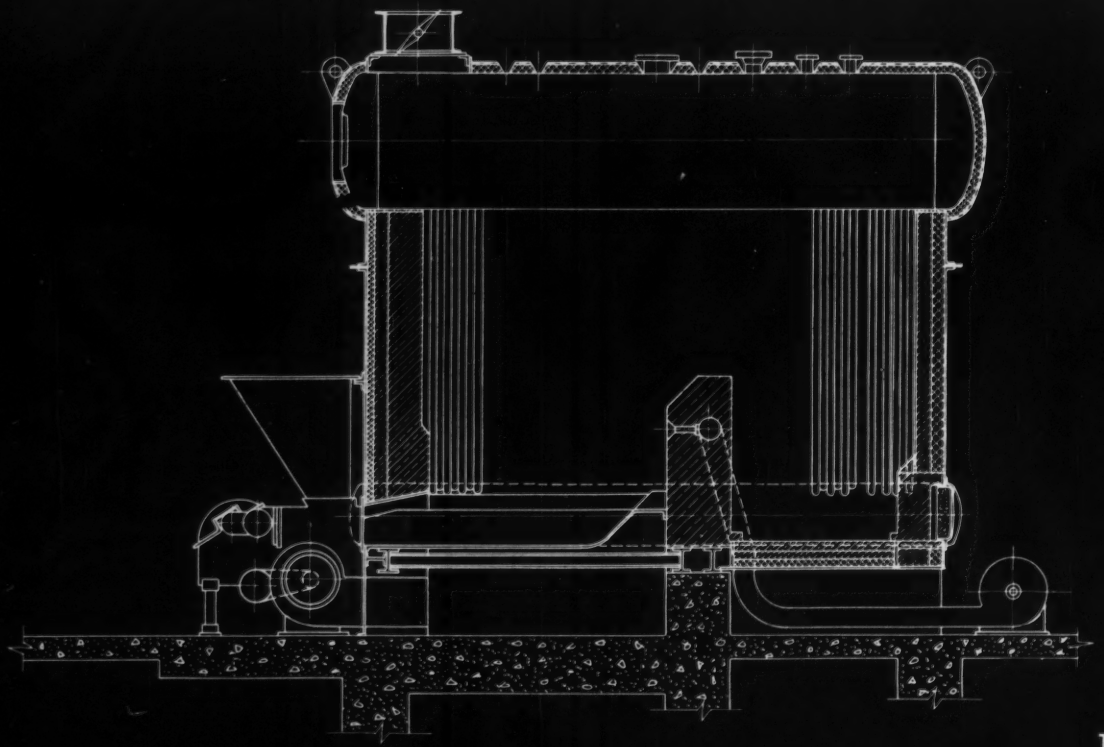
you can take full advantage of the fuel situation with

WICKES

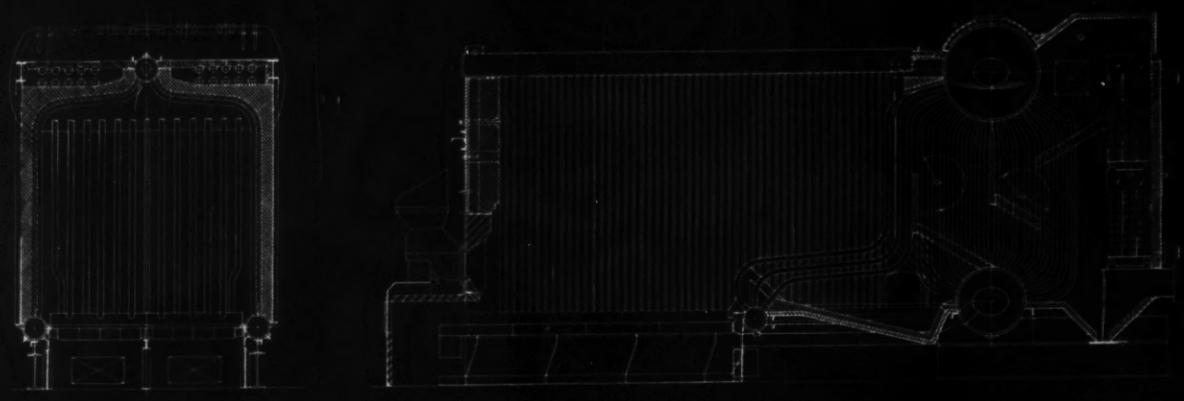
PACKAGE STOKER-FIRED STEAM GENERATORS

Designed and built to WICKES recognized standard of excellence, engineered to WICKES high standard of efficiency

These stoker-fired WICKES generators are compact, package water tube boilers, custom-engineered to your exact steam generating requirements. Semi-automatic in operation and convertible from stoker-fired to either gas or oil fired, these WICKES generators are built to the highest standards of workmanship to give you the same efficiency of operation that you have come to expect from all WICKES-built boilers. They are built in a variety of designs to meet size, space and fuel conditions. For complete information on these WICKES stoker-fired units as well as the complete line of WICKES water tube steam generators, ask the WICKES sales representative nearest you to call . . . offices in principal cities*.



TYPE A



TYPE S-3

TYPE A

WICKES

BOILER CO., SAGINAW 13, MICHIGAN

RECOGNIZED QUALITY SINCE 1854

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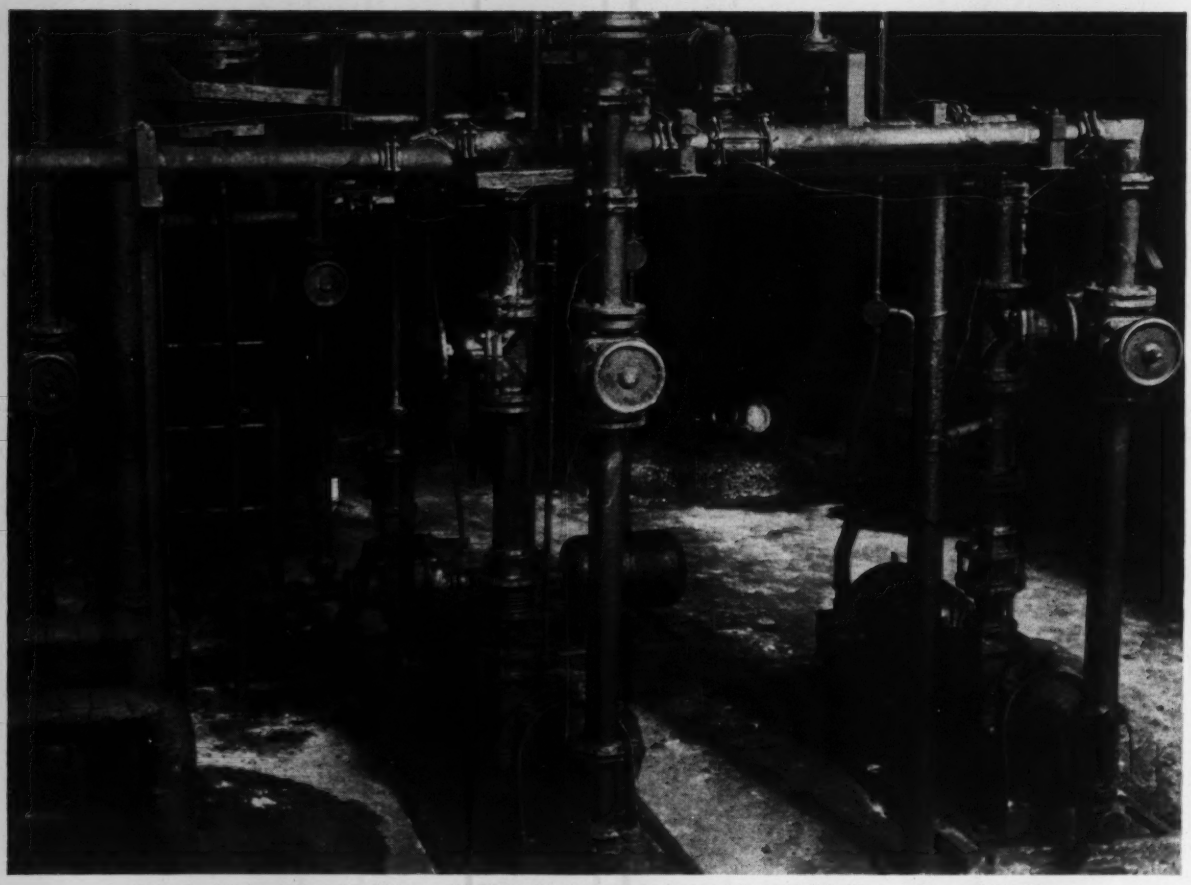
DIVISION OF THE WICKES CORPORATION



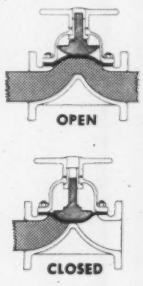
Glass-lined Grinnell-Saunders Valves, with Teflon Diaphragms, on benzene hexachloride lines at Diamond Alkali's Greens Bayou, Texas, plant. Hundreds of other Grinnell Diaphragm Valves are used in other areas of the plant.

How a manufacturer of benzene hexachloride solved a serious valve leakage problem

Valving at Diamond Alkali's Greens Bayou, Texas, plant had become expensive. Leakage of a product containing 30% to 40% benzene and free chlorine released fumes and caused rapid corrosion of the metal parts of the valves used previously, as well as of adjacent equipment.

This problem was corrected when Grinnell-Saunders Diaphragm Valves were used. The first replacement of any part of the Grinnell Valves did not occur for two years, and this was the diaphragm *only*. The former valves had to be *completely* replaced every one to two months! Bodies of the Grinnell valves lasted four years. In short, when Grinnell-Saunders Diaphragm Valves were installed, stem leaks ceased; corrosion was eliminated; and downtime to install new valves was practically ended.

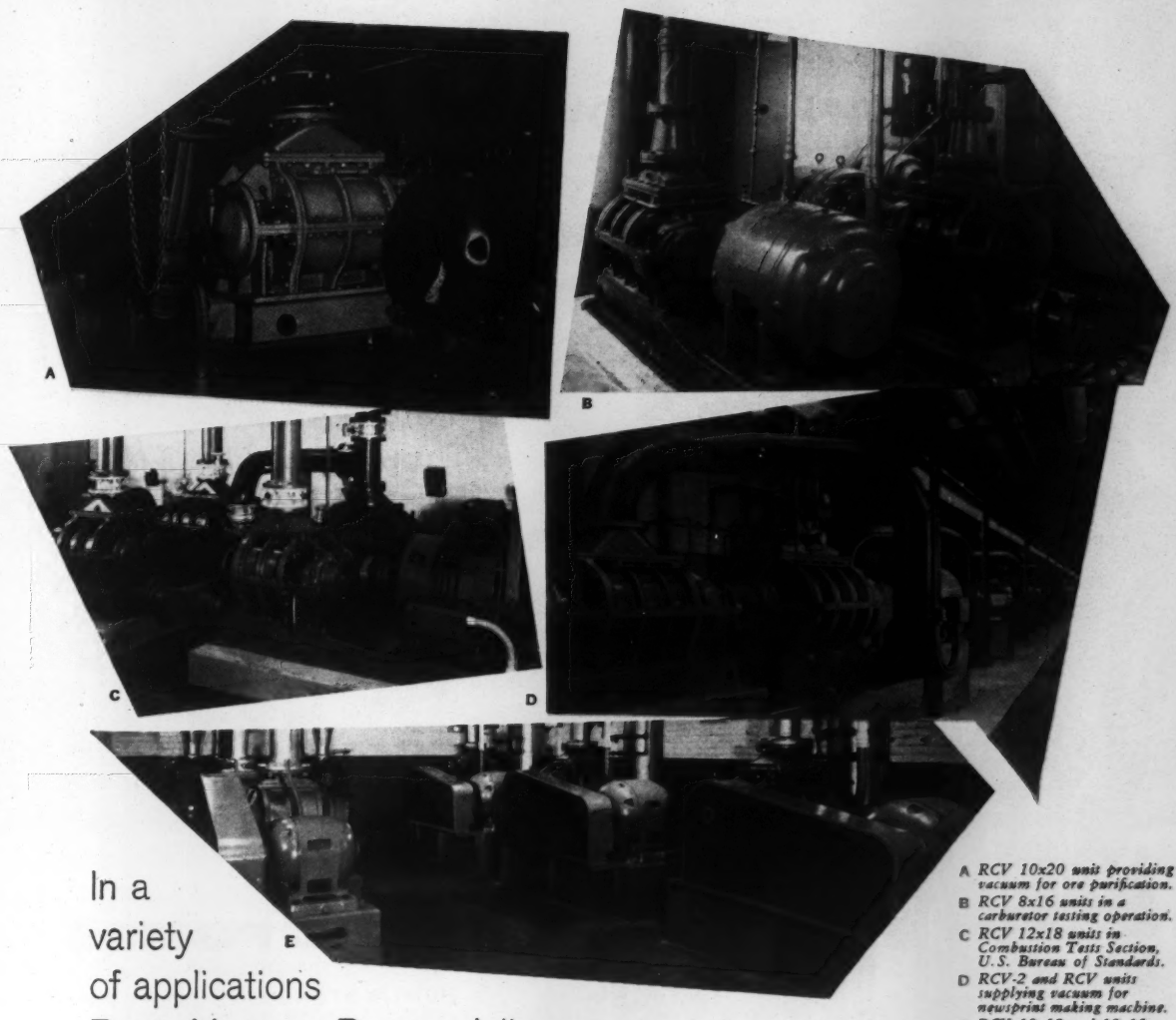
For further facts about Grinnell-Saunders Valves, see Grinnell's insert in Chemical Engineering Catalog, or Sweet's Plant Engineering File — or write directly to Grinnell Company, Providence 1, Rhode Island.



- Diaphragm lifts high for streamline flow in either direction
- Diaphragm presses tightly to effect positive closure
- No packing glands to need attention
- Diaphragm easily replaced without removing valve body from the line
- Wide choice of body, lining and diaphragm materials

GRINNELL-SAUNDERS DIAPHRAGM VALVES

GRINNELL COMPANY, PROVIDENCE 1, R. I. • BRANCH WAREHOUSES AND DISTRIBUTORS FROM COAST TO COAST
PIPE FITTINGS • VALVES • PIPE HANGERS • PREFABRICATED PIPING • UNIT HEATERS • PIPING SPECIALTIES



A *RCV 10x20 unit providing vacuum for ore purification.*
B *RCV 8x16 units in a carburetor testing operation.*
C *RCV 12x18 units in Combustion Tests Section, U.S. Bureau of Standards.*
D *RCV-2 and RCV units supplying vacuum for newsprint making machine.*
E *RCV 10x18 and 10x15 units serving cigarette-making machines.*

In a variety of applications Roots Vacuum Pumps deliver

MORE CFM PER DOLLAR

The high operating speeds of Roots-Connersville blowers for vacuum service result in lower horsepower requirements. Power savings of as much as 25% are possible. What is more, the simple, rugged rotary positive design of these vacuum pumps provides additional savings in initial cost, long-term investment, maintenance and floor space. These advantages are being demonstrated in a wide variety of mining, paper making, chemical processing, general manufacturing and testing operations.

Type RVS vacuum blowers are offered for efficient low volume service. Designed to handle capacities ranging from 30 cfm to 1,000 cfm, they can operate up to 20" Hg. vacuum in single stage construction.

Type RCV units are available for air and gas handling capacities from 500 to 13,000 cfm and are recommended for vacuums up to 17" Hg.

Type RCV-2 compound units consist of two RCV's on a single driving shaft and are recommended for highest efficiency from 18" to 27" Hg. vacuum when handling capacities from 1,500 to 15,000 cfm.

Your nearest Roots-Connersville sales engineer can give you full details. Or write for Bulletin VP-158 (RCV) and S-RVS-159 (RVS).

ROOTS
—first in air and gas handling equipment

ROOTS
CONNERSVILLE
Rotary Positive Blowers & Meters • Gas Pumps • Vacuum Blowers • Spiralaid® Compressors • Centrifugal Blowers

DRESSER INDUSTRIES INC.
OIL • GAS • CHEMICAL
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ROOTS-CONNERSVILLE BLOWER DIVISION • 560 Michigan Ave., CONNERSVILLE, INDIANA
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company

"A ~~MAN~~ IS KNOWN BY THE *customers it* ~~COMPANY HE~~ KEEPS"

Repeat orders are a continual source of pride at Pacific. They indicate the success of our pumps in satisfying the needs of our customers.

Since 1923, Pacific Pumps Inc. has been supplying dependable centrifugal pumps to refineries, chemical plants and similar process installations. Thousands of Pacific process pumps are now contributing to plant efficiency throughout the world.

Pump design and manufacture are not the only features of this enviable performance record. Pacific has a skilled service engineering staff. These men are available when needed... anytime, anywhere.

For complete information about Pacific centrifugal pumps for process service, write to:

PACIFIC PUMPS

Inc... A Division of Dresser Industries, Inc.

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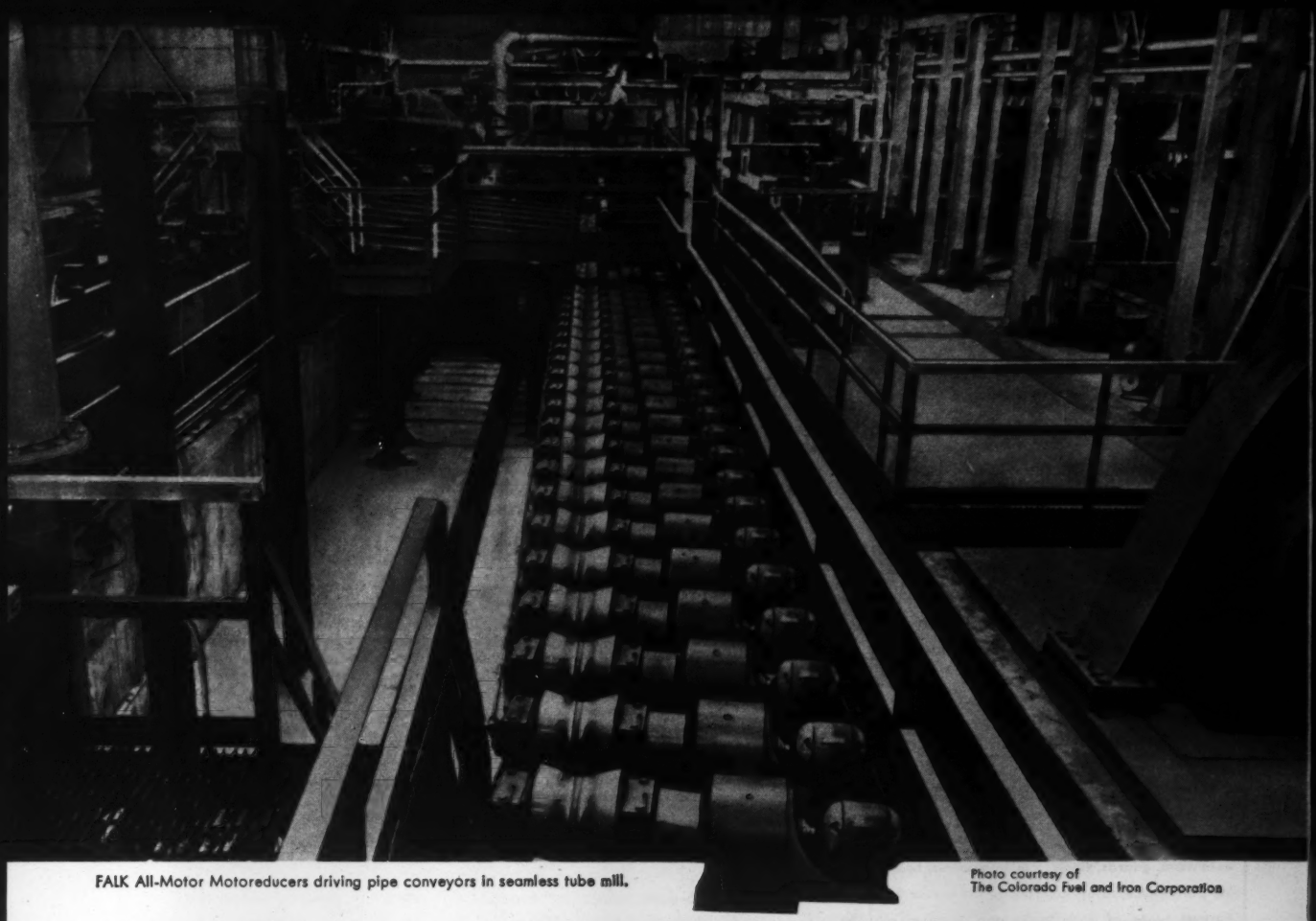
PACIFIC®

Offices in all Principal Cities



FALK All-Motor Motoreducers driving pipe conveyors in seamless tube mill.

Photo courtesy of
The Colorado Fuel and Iron Corporation

You get these "extras" when you buy FALK *all-steel* Motoreducers

1. **Freedom from damaged housings.** The exclusive FALK *all-steel* construction gives full protection from cracked housings or torn-off feet...plus twice the ability of cast iron to maintain vital alignment.
2. **12-15% reserve load-carrying capacity** in the gears, by AGMA standards. The extra-depth, high pressure angle helical gears are another FALK exclusive ...they assure better operation and longer gear life.
3. **Highest known gear efficiency**—98½% per gear train under full load! This means maximum productive work for your power dollar.
4. **Longer service life**...advanced FALK design makes it possible to machine both bores for each shaft assembly at one time, thus eliminating possible accumulation of tolerances that occurs when individually machined parts are assembled. The result—better alignment of revolving elements that permits units to transmit rated capacity longer.
5. **Standard units to fit your needs.** Integral and All-Motor® Motoreducers are available in horizontal, vertical and right angle types...a type for every use.

Units are available up to 75 hp; output speeds from 780 rpm down to 1.2 rpm. Prompt delivery from factory, warehouse or distributor stocks. Ask your FALK Representative or Authorized FALK Distributor for *Bulletin 3100.*

THE FALK CORPORATION, MILWAUKEE 1, WIS.

MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

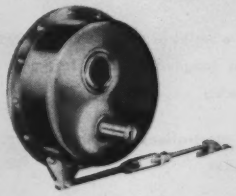
Representatives and Distributors in most principal cities

FALK

...a good name in industry

THE FALK ALL-MOTOR® MOTOREDUCER
the original All-Motor unit

(Shown) Horizontal concentric model. Also available in right angle and vertical types.



THE ALL-STEEL FALK® SHAFT MOUNTED DRIVE

Proved best for the countless industrial applications where a reducing unit mounting directly on shaft of the driven machine is indicated.

Units from 1/2 to 50 hp. Ratios —4:1, 14:1 or 24:1. Torque capacity up to 41,000 lb-in (in standard units). Prompt shipment from stock. For details, ask for *Bulletin 7100.*

SAFETY CODE FOR POWERED INDUSTRIAL TRUCKS

The safety requirements of this 1959 Revision relate to elements of design, operation, and maintenance of power-driven trucks used to carry, push, pull, lift, stack, or tier materials, such as:

powered industrial truck	nonelevating truck
rider truck	industrial tractor
motorized hand truck	industrial crane truck
high-lift fork truck	end-control truck
low-lift truck	center-control truck
high-lift platform truck	self-loading truck

INCLUDED ARE:

safety provisions for capacity rating and fork truck stability, warning device, driver's overhead guard, load back rest, forks and fork extensions, guards, steering arrangements, braking performnce, safety control and brakes for the various types of fork trucks and, location of controls;

general safety regulations applying to operator's qualifications, fuel handling and storage, battery charging and charging facilities, obstructions, dockboards, lighting for operating areas, control of obnoxious gases and fumes, use of safety chocks;

specific safety rules for truck operators, formulated to reduce in-plant traffic accidents;

maintenance and inspection provisions to prevent trucks from becoming hazardous;

a series of tilting platform tests for determining longitudinal and lateral stability of fork trucks;

illustrations of ten different types of fork trucks.

B56.1—1959 **$1.50**

The first standard which touches on the fundamental design of materials handling systems

AMERICAN STANDARD PALLET SIZES

This new standard is the result of a project in which more than sixty national organizations participated for the purpose of selecting the minimum of sizes of pallets for noncaptive use which will provide a maximum of efficiency, economy, interchangeability, and flexibility, especially when used in the U.S. rail, truck, maritime, and air transport services.

The series of eleven pallet sizes (eight rectangular and three square) which this standard provides, includes four sizes under consideration by the International Organization for Standardization as well as those in use by companies and the military services. The standard applies to pallets irrespective of the type of material used, i.e., wood, metal, paper, etc., and covers those with 1½" overhang of the load and without any overhang. "Areagrams" charts are included to show relationships of pallets to the inside area of the modern carrier equipment and to the weight and volume of goods which could be carried.

Among the advantages of wide acceptance of this standard are: More flexibility, more uses for pallets, maximum utilization of loading space, and reduction in returns of empty pallets, since they will be largely interchangeable.

MH 1.1—1959 **$2.00**

An authoritative guide that covers every phase of materials handling

MATERIALS HANDLING HANDBOOK

Here has been condensed and organized virtually the entire literature of modern materials handling, stressing the economies and short-cuts of the greatest importance throughout industry.

The Handbook gives actual operating experiences of hundreds of companies in all segments of manufacturing and industry. It offers advice on choosing the equipment to do the job, timing and coordinating job movements, factory planning, production control, industrial packaging, yard handling, warehousing, truck-rail-marine- and air-terminal handling, etc. It explains the cost methods and includes forms for determining the cheapest shipping methods for varying loads and destinations.

Supplementing the text discussion are photographs, diagrams, and time-saving picturizations which show typical installations of specialized and general purpose apparatus, innovations in machinery and design, standard and unusual equipment applications, and model layouts and floor plans.

In short, the Materials Handling Handbook provides the means for making a scientific efficiency check on every phase of operation—from hauling and storing raw materials to movement through the plant, packaging, stock piling, and safe delivery to the buyer.

1750 Pages **961 Photographs, Line Drawings, and Tables** **68-Page Index**

Flexible Binding **$20.00**

Up-to-date safety for modern conveyors is assured when the

SAFETY CODE FOR CONVEYORS, CABLEWAYS, AND RELATED EQUIPMENT

is your guide for the safe construction, elements of design, their installation, operation, and maintenance.

Covering sixty-six different types of conveyors, this standard gives . . . . the terms and definitions of their parts and components . . . . the safety requirements that apply to the design features of conveyors, such as belts, chains, pulleys, sprockets, blocks, bearings, backstops, brakes, and overload-protection . . . . the recommendations for their installation, inspection, maintenance, and operation; for related structures; and for prime movers and controls. Additionally the code provides specific safety regulations for aerial cableways, slat conveyors, belt conveyors, pneumatic conveyor systems, bucket conveyors, chain conveyors, roller and wheel conveyors, live roll conveyors, vertical conveyors, screw conveyors, and aerial tramways and the traffic control system for them.

B20.1-1957 **$1.50**

Another American Standard that has found major application is . . .

SAFETY CODE FOR CRANES, DERRICKS, AND HOISTS

This code applies to the construction, installation, inspection, maintenance, and operation of cranes and derricks driven by steam engines, electric motors, or internal combustion engines to their runways; to simple drum hoists of whatever motive power; to overhead electric hoists and their runways; and to overhead air hoists; also to hand powered derricks. For every type of equipment included general rules are given covering welded construction, foundation anchorage, cages and machine houses, lubricating devices, mechanical guarding, electric equipment, brakes, and runways. On inspection, testing, and maintenance, rules are provided for parts subject to wear, locking devices, brakes, chain and chain drives, cleaning, and repair. On operation, the recommendations apply to the conduct of and qualifications for operators, the safe working load of the equipment, signals, brake testing, firing boilers, etc. Specific rules included are for overhead and gantry cranes; locomotive, crawler, and motor truck cranes; derricks; simple drum hoists; overhead electric hoists and base-mounted electric hoists; and air hoists

B30.2-1952 **$2.50**

20% discount to ASME members

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 West 39th Street, New York 18, N. Y.

ANNOUNCING A NEW OXIDATION RESISTANT

GRAPHITAR®

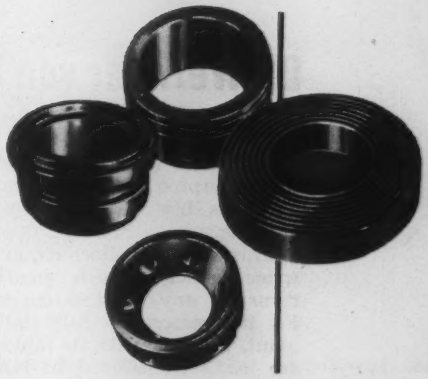
(CARBON-GRAPHITE)

FOR HIGH TEMPERATURE APPLICATIONS

Culminating five years of intensive research, engineers of The United States Graphite Company have developed a new oxidation resistant GRAPHITAR. In exhaustive tests, GRAPHITAR parts were exposed in an oxidizing atmosphere (air) at 1200 degrees F and after 200 hours, the GRAPHITAR showed a weight loss of less than six percent!

GRAPHITAR, which is available in many grades, is a versatile engineering material with unusual and outstanding properties that make it ideal for tough applications. It is non-metallic, resists chemical attack, has self-lubricating properties and a low coefficient of friction. It is mechanically strong, lighter than magnesium and is the perfect material for packing rings, pressure joint seals, clutch release bearings, fluid coupling seals, piston rings, pump liners and vanes.

For more information on this new oxidation resistant GRAPHITAR and its applications, write the GRAPHITAR product manager on your company letterhead.



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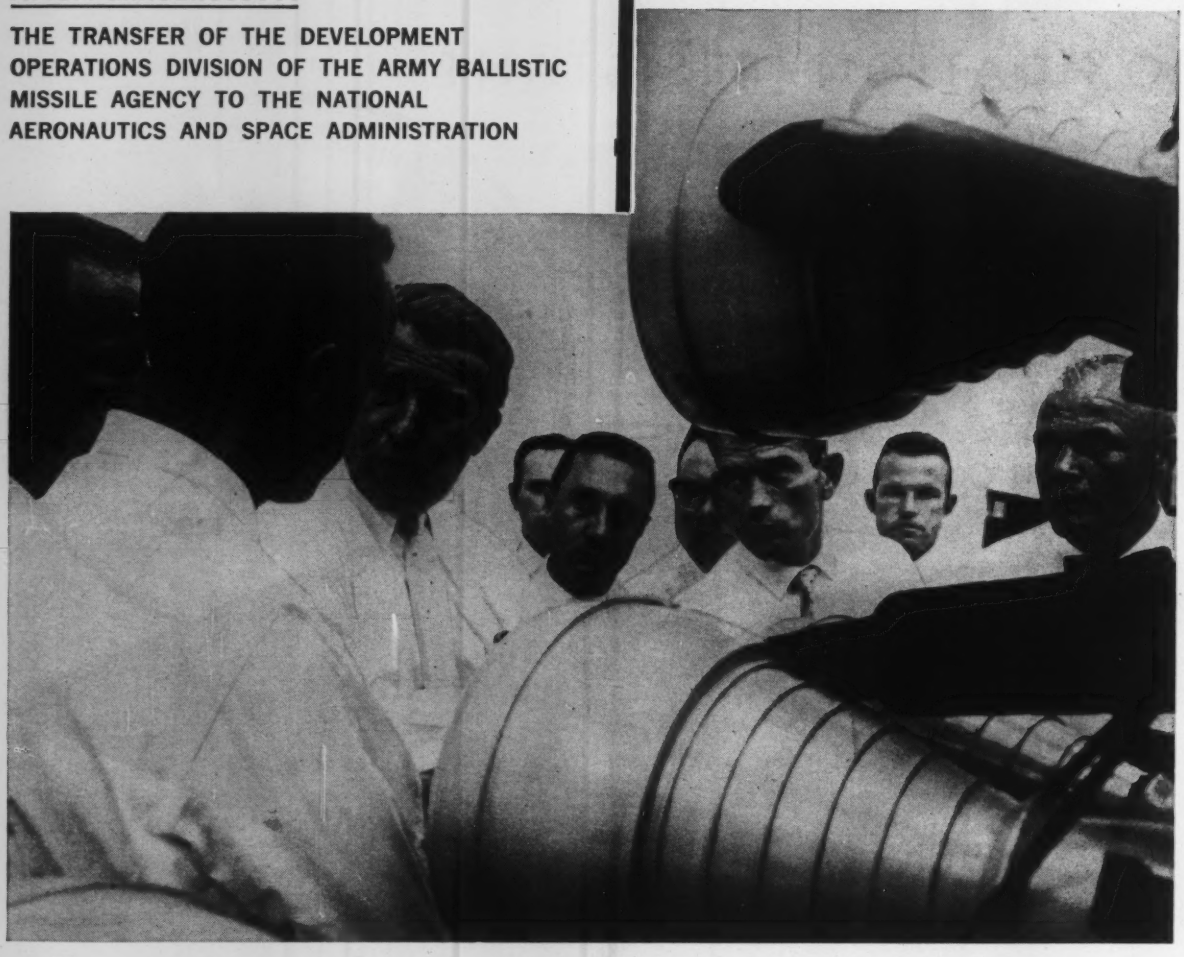
THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 4, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

NASA announces . . .

THE TRANSFER OF THE DEVELOPMENT OPERATIONS DIVISION OF THE ARMY BALLISTIC MISSILE AGENCY TO THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION



Dr. Wernher von Braun, director of the new NASA Marshall Space Flight Center in Huntsville, Ala., pictured with NASA's Mercury Astronauts

Dr. Wernher von Braun and his space team join NASA

The National Aeronautics and Space Administration leads the nation's efforts to find, interpret and understand the secrets of nature as they are revealed in the laboratory of space.

This vigorous effort requires boosters for space vehicles which greatly exceed the thrust of any boosters currently available. For this reason, the $100 million Huntsville plant, together with its famous space team, are being transferred to NASA. The new NASA facility in Huntsville will be known as the George C. Marshall Space Flight Center.

NASA is now the largest civilian research organization in the United States. For details about outstanding professional opportunities, address your inquiry to the Personnel Director of any of these NASA centers:

NASA Goddard Space Flight Center
Washington 25, D. C.

NASA Flight Research Center
Edwards, California

NASA George C. Marshall Space Flight Center
Huntsville, Alabama

NASA National Aeronautics and Space Administration

Fairbanks Nº 1

a scale, our first one.
an imagination of iron, brass, copper and lead,
fashioned in a New England workshop.
inanimate.

but it spoke—
a different kind of language,
of pounds and ounces and fractions thereof
and it spoke only the truth.

it felt—
the roundness of grain, the smoothness of marble,
the sweetness of candy and the authority of gold.

it heard—
the sound of life, babies newborn
it cradled them and recorded their growth
until pounds and ounces were replaced
by years and months.

it traveled—
by packet boat down the Mississippi,
by clipper ship to England,
The Sandwich Isles, the Indies,
South America and China.
better known throughout the world
than anything else made in America.

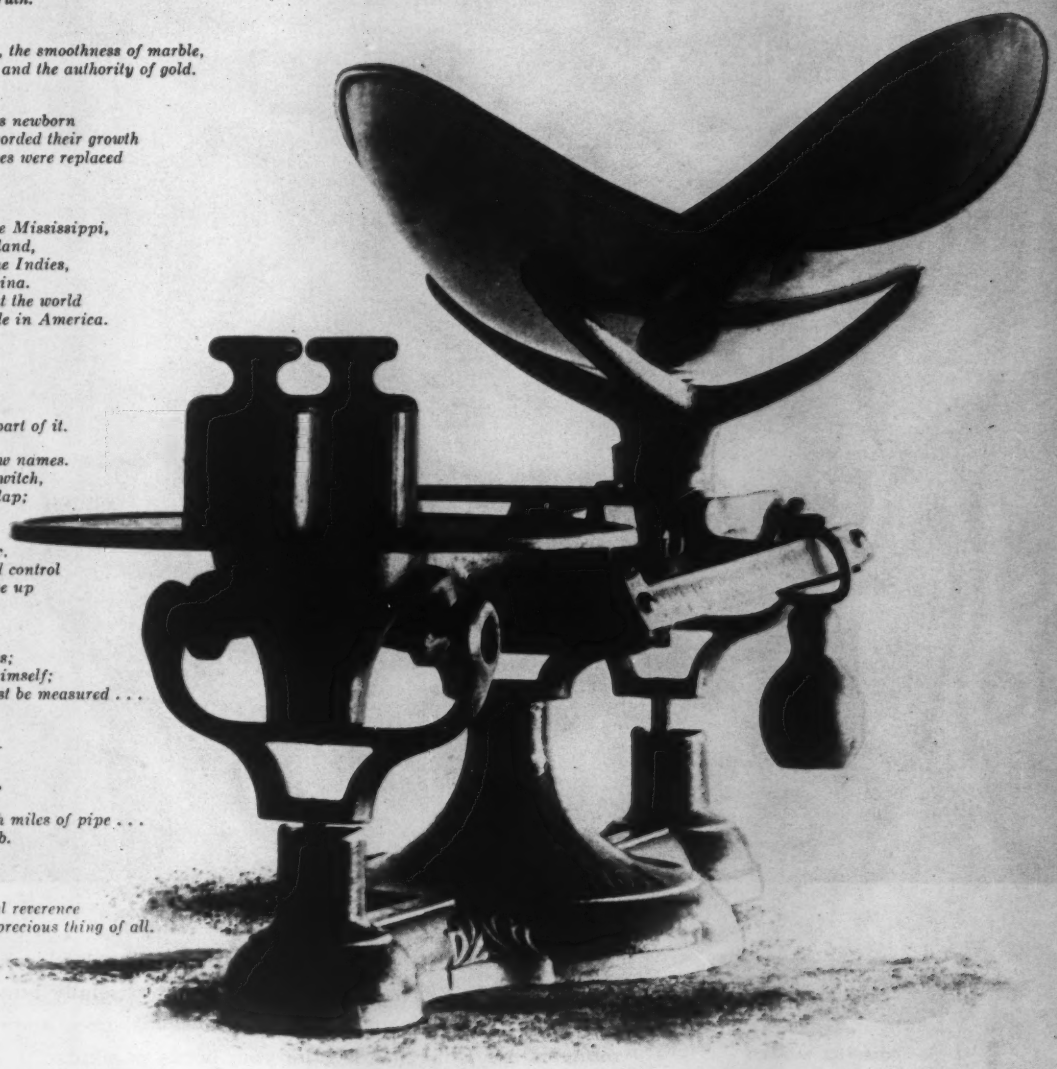
it was relied on
by farmers, merchants,
scientists and doctors.
it witnessed history;
influenced it and was part of it.

its descendants have new names.
floaxial dial, mercoid switch,
reed switch and cotton lap;
remote control,
printomatic,
electronic and levetronic.
all serve to evaluate and control
the substances that make up
the universe.

raw materials
or manufactured articles;
things unseen or man himself;
all have weight and must be measured . . .
our scales do the job.

and the new challenge—
weight in motion . . .
freight trains in transit,
trucks too busy to stop,
liquids coursing through miles of pipe . . .
our scales will do the job.

but this was our first—
Fairbanks No. 1
and we hold it in special reverence
for it weighed the most precious thing of all.
it weighed an idea.



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A MAJOR INDUSTRIAL COMPONENT OF FAIRBANKS WHITNEY CORPORATION, NEW YORK

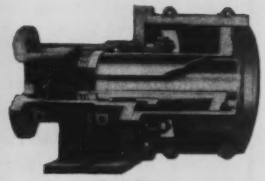
Scales for heavy industry and for business; scales for science and for the home. Scales that weigh milligrams or millions of pounds. Scales that weigh missile fuel loads at Cape Canaveral; trucks on the Golden Gate Bridge; onions at your neighborhood grocer's . . . we make every kind of scale for every kind of purpose, including electronic scales. We are the Number 1 manufacturer of scales and automated weighing systems in the world.

If you have a problem where the careful calculation of weight is of vital importance, please write to Mr. Robert W. Kerr, President, Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Illinois.

ONLY ADSCO HAS ALL 3 TYPES OF EXPANSION JOINTS

CORRUFLEX PACKLESS

RAM-PAK



SLIP TYPE

...real peace of mind, the result of doing business with completely reliable Adsco. For more than 80 years, Adsco has carefully handled customers' expansion problems in their piping systems, from engineering through manufacture. Consult Adsco for your peace of mind.

Write for comprehensive catalogs

ADSCO ENGINEERED PRODUCTS

Sold, Engineered and Manufactured by

YUBA HEAT TRANSFER DIVISION

HONESDALE, PA.

World's Oldest and Largest Manufacturer of Packed and Packless Expansion Joints

YUBA

YUBA CONSOLIDATED INDUSTRIES, INC.

YUBA — A growth corporation serving growth industries

chemical
petroleum
steam — electric
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aeronautics
construction
heating
air-conditioning
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Performance makes the world of difference

NUCLEAR

for Atomic Power Plants

4-inch, 300-pound Steel Bell-O-Seal "Y" Valve for molten metal service. It has hard faced seat and disc, and is electric motor operated.

Powell . . . world's largest family of valves

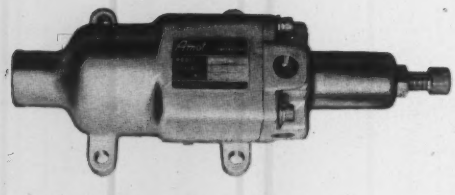
Powell has precision-designed special Valves to handle molten metals and other radioactive materials in atomic power plants—vital and hazardous fluids that must pass through the valves without the slightest leakage or failure.

Painstaking quality control is rigidly enforced in every step of manufacture. Every machine operation is accurately gauged. All parts are thoroughly cleaned and degreased. And every nuclear valve is given an actual line test—plus a snifter or mass spectrometer test.

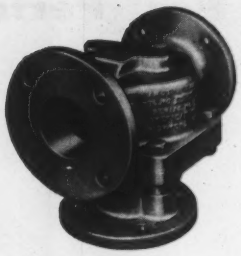
For complete information, consult your Powell Valve distributor. Or call us direct. We'll be pleased to inform you about Powell Nuclear Valves as well as our complete line of Powell Quality Valves.

THE WM. POWELL COMPANY • DEPENDABLE VALVES SINCE 1846 • CINCINNATI 22, OHIO

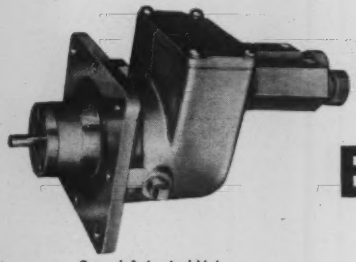
Diaphragm Gas Valves
2" & 3" Pipe Size
Model 2180



Vibration Valve
3-Way Control
Model 2900



Thermostatic Valves
½" to 6" Pipe Size
MODEL B

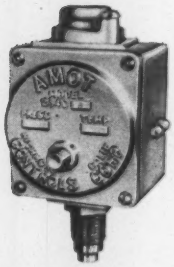


Speed Actuated Valve
3-Way Control
Model 4017

AMOT

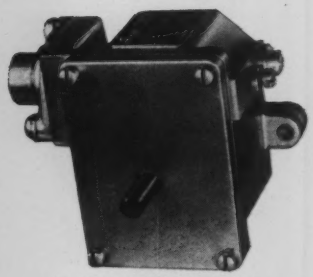
ENGINE CONTROLS

A COMPLETE LINE



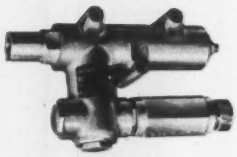
Safety Control Switch
Pressure-Temperature
Model 2340

Already recognized by owners and original equipment manufacturers as the standard of quality and reliability in engine controls and thermostatic valves, AMOT is expanding its product line to provide greater flexibility in function control.



Low Pressure Safety Control
Small Engines & Equipment
Model 2800

Illustrated on this page are some of the new products designed particularly for automatic or semi-automatic control systems. Models 2900, 4017, 4021, 4023 include 3-way balanced valves.



High Pressure Valve
3-Way Control
Model 4023

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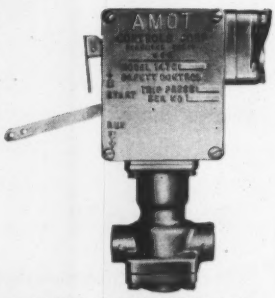

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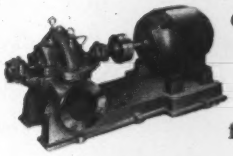

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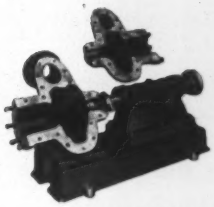

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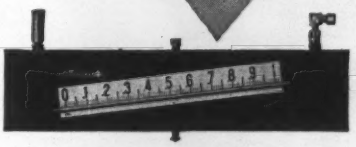

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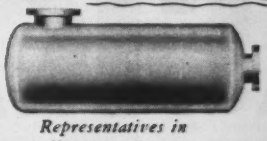

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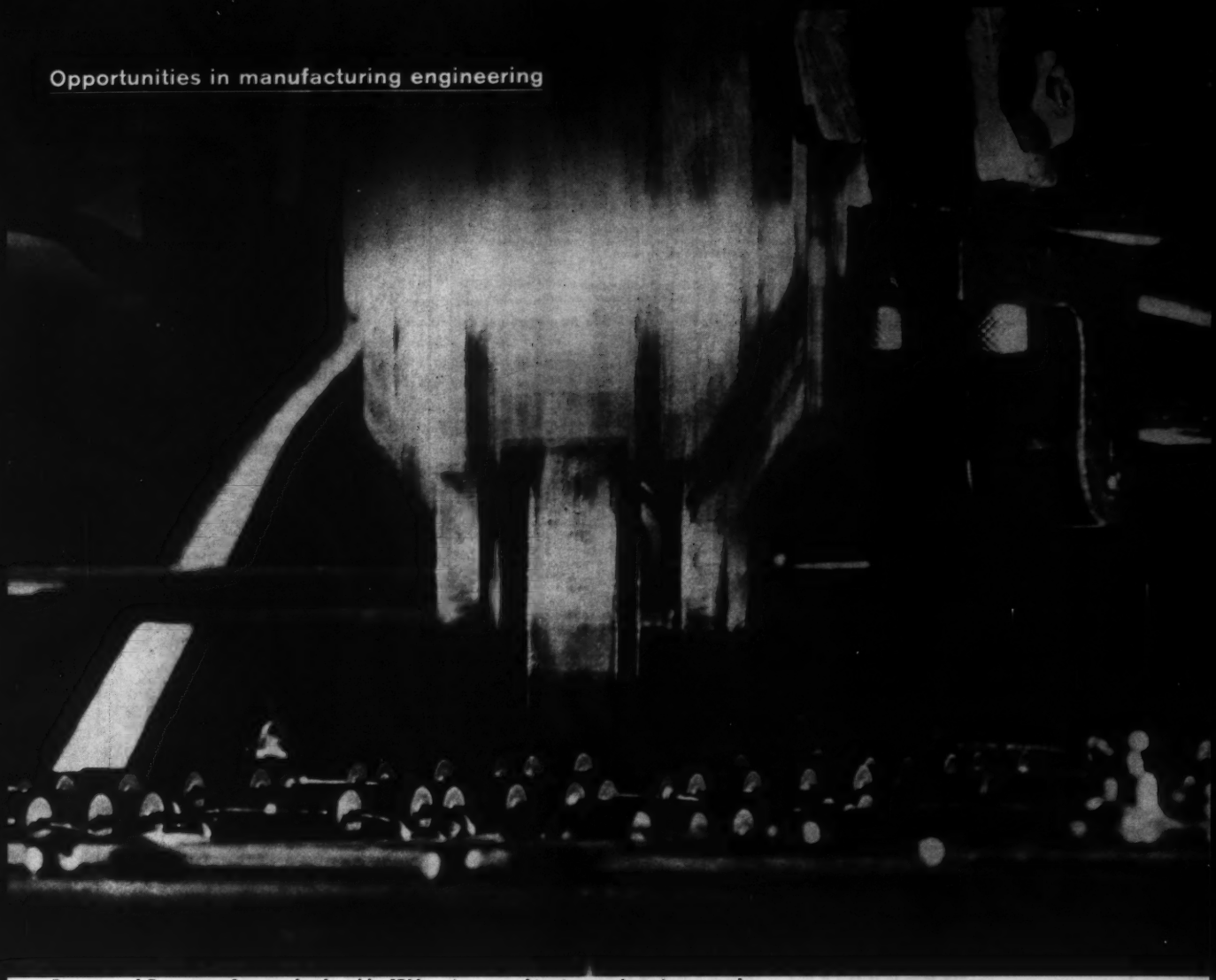

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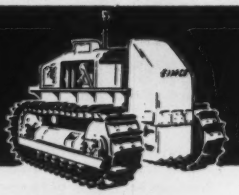

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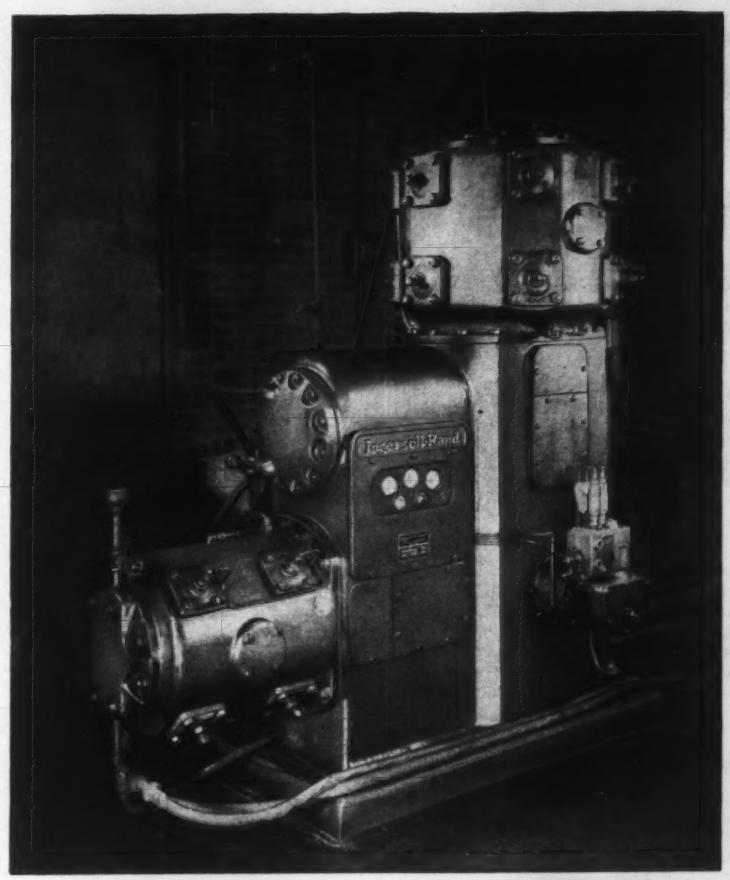

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INDEX TO ADVERTISERS

ACF Industries (Inc.)
W-K-M Division 15
Adams, R. P., Co. 171
Air Products (Inc.) 203
*Allis-Chalmers Mfg. Co. 201
Aluminum Company of America 8, 9
*American Pulverizer Co. 171
ASME Publications 184
Mechanical Catalog 192
Amot Controls Corp. 190
Associated Spring Corp. 208
Atlantic Research Corp. 200

*Babcock & Wilcox Co. 200
Boiler Div. ..... 2nd Cover
Tubular Products Div. 4
*Badger Mfg. Co. 21
Battelle Memorial Institute 197, 201
Bellofram Corp. 2
Bonney Forge & Tool Works 155
Bridgeport Thermostat Div.
Robertshaw-Fulton Controls Co. . 152, 153
*Buffalo Pumps
Div. Buffalo Forge Co. 191

*Chicago Bridge & Iron Co. 25
Clarage Fan Co. 14
Clark Bros. Co.
Div. of Dresser Operations (Inc.) .. 202
Clearprint Paper Co. 30
*Combustion Engineering (Inc.) 22, 23
Consolidated Electrodynamics Corp. . 176
Consolidated Western Steel
Div. of United States Steel Corp. .. 200

Dresser Industries (Inc.)
Pacific Pumps (Inc.) 182
Roots-Connersville Blower Div. 181
du Pont, E. I., de Nemours & Co. 198

Eimco Corp. 202
Ellison Draft Gage Co. 195

*Fairbanks, Morse & Co.
Compressor Div. 17–20
Scale Div. 187
*Falk Corp. 183
Fiske Bros. Refining Co.
Lubriplate Div. 167
*Flexonics Corp. 31
Foote Bros. Gear & Machine Corp. .. 1
Fulton-Sylphon Div.
Robertshaw-Fulton Controls Co. 151

*Gear Specialties (Inc.) 6
General Electric Co. 176, 201
General Motors Research Labs. 16
*Golden-Anderson Valve Specialty Co. 172
Gray Tool Co. 159
*Grinnell Co. 180

*Ingersoll-Rand Co. 205
International Business Machines 199

Jenkins Bros. 148
Johnson, Carlyle, Machine Co. 11
Johnston Pump Co.
Div. Youngstown Sheet & Tube Co. 165

*Keeler, E., Co. 27
Kellogg, M. W., Co. 197
Kennedy Valve Mfg. Co. 24
Koppers Co.
Piston & Sealing Rings 34

Lefax Publishers 195
Lenape Hydraulic Pressing &
Forging Co. 157
Los Alamos Scientific Lab. 202
Lubriplate Div.
Fiske Bros. Refining Co. 167
Lukens Steel Co. 7
Lunkenheimer Co. ..... 3rd Cover

McDonnell & Miller (Inc.) 150

Martin Co., Denver Div. 29
Mercoid Corp. 174
*Midwest Piping Co. 193

National Aeronautics and Space
Administration 186
National Exposition of Power &
Mechanical Engrg. 26
*New York Blower Co. 161
Niagara Blower Co. 158
Nordberg Mfg. Co. 177
North American Philips Co. 201

Ohio Gear Co. 154

Pacific Pumps (Inc.)
A Div. of Dresser Industries (Inc.) 182
Perfection Gear Co.
American Stock Gear Div. 168
Powell, William, Co. 189
Pulp & Paper Research Centre (Inc.) 200
Pulsation Controls Corp. 195

Raybestos-Manhattan (Inc.)
Manhattan Rubber Div. 13
Packing Div. 162
Robertshaw-Fulton Controls Co.
Bridgeport Thermostat Div. 152, 153
Fulton Sylphon Div. 151
Rockford Clutch Div.
Borg-Warner 169
Roots-Connersville Blower Div.
Dresser Industries (Inc.) 181
Rust-Oleum Corp. 32, 33

Shenango Furnace Co. 160
Sly, W. W., Mfg. Co. 207
*Southwest Products Co. 195
*Syntron Co. 156

Thomas Flexible Coupling Co. 166
Timken Roller Bearing Co. ..... 4th Cover

Uni-Flex Mfg. & Engrg. (Inc.) 195
United States Graphite Co.
Div. Wickes Corp. 12, 185

*Vogt, Henry, Machine Co. 196

W-K-M Div. of ACF Industries (Inc.) 15
Westinghouse Electric Corp.
Atomic Power Div. 175
*Wickes Boiler Co.
Div. Wickes Corp. 178, 179
Williams Gauge Co. 158
Wollensak Optical Co. 173
*Worthington Corp. 28

*Yarnall-Waring Co. 147
Yoder Co. 170
York Corp.
Sub. Borg-Warner Corp. 10
*Yuba Consolidated Industries (Inc.).
Adsco Division 188

---

* The asterisk indicates that firm has product catalog in the 1960 Mechanical Catalog.

Your attention is directed to

Design Engineering Insert 139–146
Keep Informed Section 149–176
Consulting Service 204
Opportunities 197–203
Engrg. Soc. Personnel Service ... 133
(Agency)

Advertisers appearing in previous 1960 issues

Acme Chain Corp.
Aero Research Instrument Co.
*Aerovent Fan Co.
*Air Preheater Corp.
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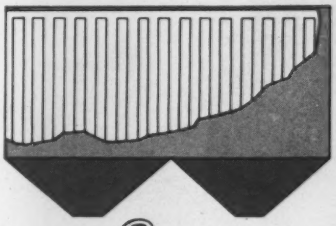

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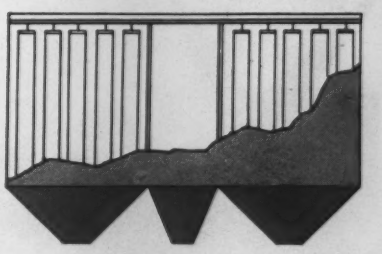

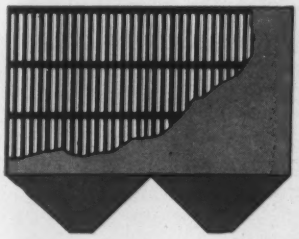

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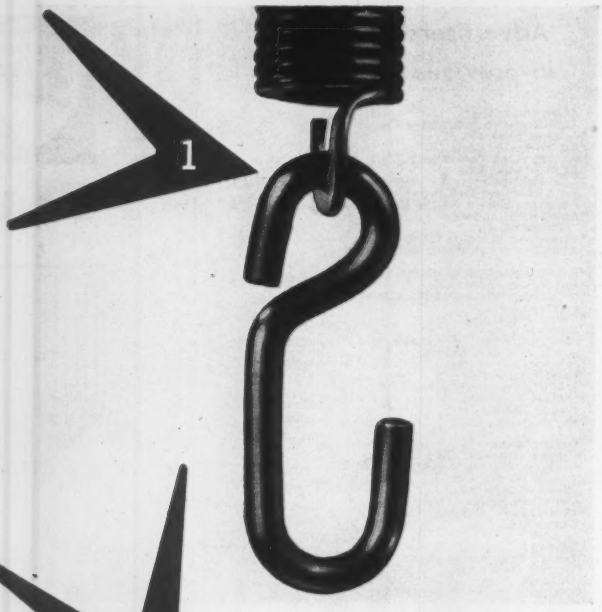
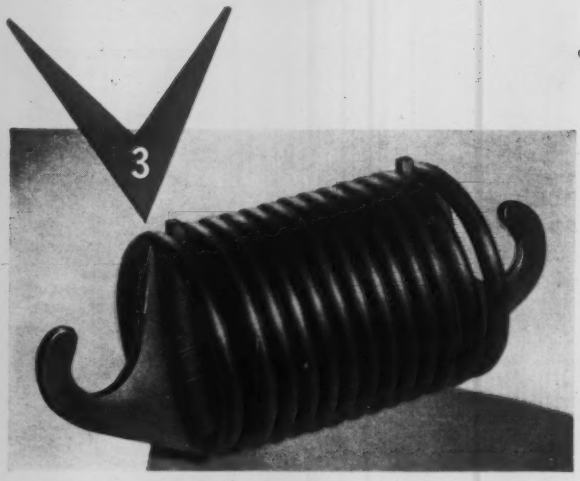
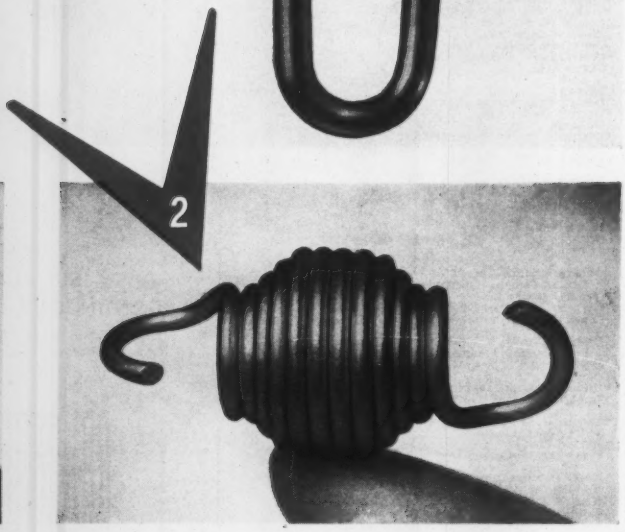
Why it pays to look at the end in the beginning







1. In this pick-arm spring for a textile machine, natural frequency vibration plus rigid end restraint caused early failure. By redesigning spring and adding swivel hook to end assembly, failure was avoided and cost reduced as well.

2. Fatigue failure caused by bending stresses occurs where end hooks join working coils. In this method of reducing the combined stress, two coils at each end are wound with a reduced diameter.

3. Another method for reducing stress concentration where end hooks join coils is to thread a flat stamping into end coils.

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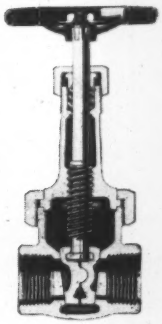

Union Bonnet for extra safety . . . *cylindrical* body design to distribute pressure uniformly and prevent distortion . . . *extra thickness* at points of greatest strain . . . these features *alone* provide the vital margin of superiority over other valves in its class. Together with Stemalloy Stems®, Non-Slip® Handwheels, and many other exclusive features, they actually put this outstanding new valve in a class by itself. You will *see why* when you compare it part-for-part with any other valve designed for similar service. Let your Lunkenheimer Distributor make this comparison for you, or write the Lunkenheimer Company, Cincinnati 14, Ohio.

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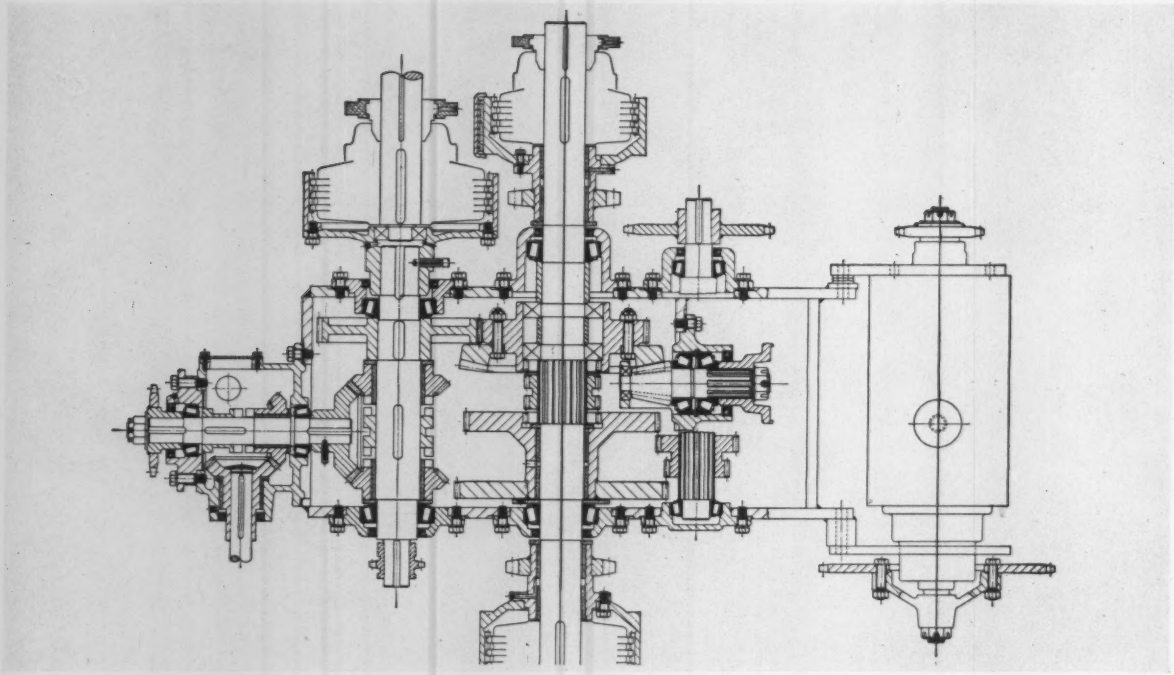
How Parsons mounts shafts to take heavy loads, keep Trenchliner digging



Parsons Company engineers used 10 Timken® tapered roller bearings to help solve load-carrying problems in their Model 150 Trenchliner. Radial and thrust loads are heavy as the Trenchliner digs fast—25 fpm., digs deep—5′9″, digs wide—26″. By using Timken bearings in the transmission assembly shown above, their engineers assured positive alignment of gears and shafts under all loads. Digging goes steadily. For more than 40 years construction equipment engineers have used Timken bearings because: 1) The taper lets Timken bearings take radial and thrust loads in *any* combination. 2) By holding shafts concentric with housings, Timken bearings make closures more effective in keeping lubricant in, dirt out. 3) The extra load carrying ability of Timken bearings takes care of the rugged going and provides longer life.

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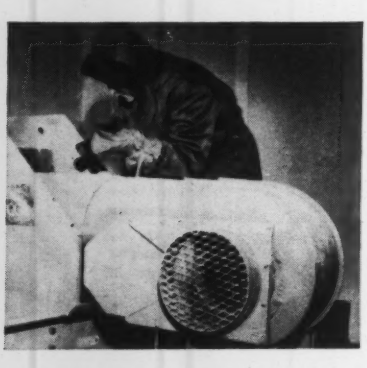

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